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AUTHOR Hendley, A. M.
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ABSTRACT

Recognizing that the fast-developing optical storage technologies provide a new dimension in publishing and information storage, retrieval, and distribution, this report examines the technical characteristics and capabilities of video and optical systems and the implications of this technology. The following aspects of optical disk systems are discussed: (1) the range of optical disk systems currently on the market or under development, including a functional classification of the different systems; (2) applications for optical disk systems in the publishing field; (3) applications for optical disk systems in the library and information field; and (4) issues relating to the use of optical disk systems where research could and is being profitably carried out in the publishing and library and information fields. References, a select bibliography, and a listing of journals, newsletters, and sources of further information are appended. (KM)

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OPTICAL DISK SYSTEMS

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OPTICAL DISK SYSTEMS

A Guide to the Technology and the Applications in the Fields of Publishing and Library and Information Work

BY

A. M. Hendley

IFLA Section on Information Technology
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Preface

The fast-developing optical storage technologies provide a new dimension in publishing, information storage, retrieval and distribution. It is not yet possible to assess exactly what impact optical media will have on libraries, information centers, archives and publishers. However, the potential impact of the technology is already apparent. The implications of the new media on libraries, archives and data base services appear to be in two major areas. On the one hand, libraries will be affected as purchasers of these new forms of media. If videodiscs and CD ROM, for example, become popular media, libraries will have to expand their collecting activities. On the other hand, the technology likely will be applied by national, academic and special collection libraries for the storage, retrieval and preservation of their collections and for distributing their machine-readable data.

In 1985 the IFLA Section on Information Technology commissioned a study on videodisc and optical disk technologies which was carried out by Mr. A.M. Hendley, Head of Research & Consultancy at the Centre for Information Media & Technology (Cimtech), Hatfield Polytechnic, United Kingdom. Mr. Hendley is an expert in this field and his work is much appreciated by the Section membership.

The main objectives of this report were to study the technical characteristics and capabilities of video and optical systems and the implications of this technology to libraries.

The study is subdivided into four chapters. After an introductory chapter outlining the different forms of optical media, production methods and costs, benefits and limitations, the following parts of the report are concerned with potential applications of optical media.

Described are in Chapter 2 two different areas where optical disk systems are applied: in the publishing field and in the library and information field.

The main part of the report studies videodisc and optical digital disk technologies and their potential role in libraries. Particular emphasis is given to the use of the new technology for preservation purposes.

The final chapter is devoted to the problems of standardisation. The report concluded that the question of standards is not only of significant importance for companies producing optical disk based systems, for software houses and systems integrators, but as well for libraries as users of optical media and optical disk workstations and equipment. Libraries need to have an interest in the establishment of standards for the new media if they wish to be able to use the same equipment for products from different sources.

We hope that this report enables librarians and interested persons to acquire more knowledge of these new technologies and their current and future place in libraries.

Christine Bossmeyer

Chapter 1

An Introduction To The Range Of Optical Disk Systems Currently On The Market Or Under Development – Including A Functional Classification Of The Different Systems

Background

Research and development of videodisc systems, particularly those optical videodisc systems based on laser recording techniques, began some 20 years ago and has now spawned a comprehensive family of optical storage systems which are beginning to have a major impact in the consumer video and audio playback market; the education and training field; publishing and the information world and the rapidly converging areas of document image storage and retrieval systems and digital data archiving subsystems.

In the late 1970's the term videodisc was used as a generic term to embrace the entire range of recording/playback techniques. Today, such has been the pace of developments, the field has expanded to the stage where it is no longer helpful to refer to all these widely different systems under the banner of videodiscs and we have therefore divided this section up into ten subdivisions, each one dedicated to one particular type of optical storage subsystem. Readers requiring a detailed technical account of the range of optical disk systems should read Cimtech Publication 23 (1) as all we have been able to provide in this brief report is a survey of the different disc systems, pointing out the main benefits and limitations of the different systems which help to define their main application areas and highlighting too the similarities between the production processes required for the different systems.

When referring to analogue read only media it is customary to use 'disc' with a 'c' but when referring to digital recordable and erasable media it is customary to use 'disk' with a 'k'. Hence one refers to 'videodisc' and 'compact disc' but 'digital optical disk' and 'erasable digital optical disks'. We apologise if readers find this alternate use of 'c' and 'k' to be unnecessarily confusing.

Videodiscs

Videodiscs were originally developed by consumer electronic companies looking for an alternative to video cassette recording systems for the lucrative domestic video playback market. A number of recording and playback techniques were experimented with including mechanical, magnetic, capacitive and optical (see table one) but the only two to be widely used commercially were capacitive systems and optical systems.

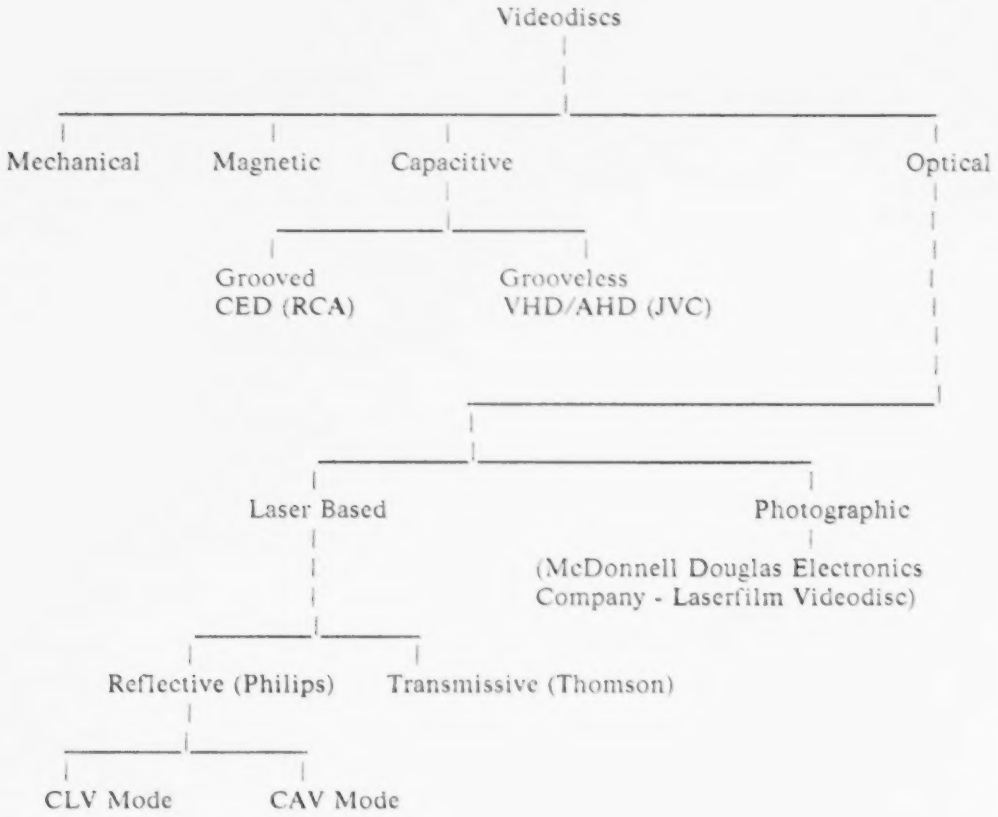

Table 1

The term capacitive is applied to those videodisc systems in which changes in capacitance between the tip of an electrode carried on a flat surface of a stylus and a metallic coating on a videodisc are used to tune an electronic circuit to reconstruct a recorded signal. The two main pioneers of this technique were RCA with their Selectavision CED system and JVC with their VHD (Very High Density) system. RCA targetted their system at the consumer market but sales were disappointing due to the lack of a record facility and they eventually pulled out. The VHD system was launched later in the UK by Thorn EMI and was targetted at the institutional market for interactive training and promotional video systems and the public entertainment market for video jukeboxes and mobile discotheque systems and, although the use of a stylus limits the degree of interactivity which can be achieved on the system, the low cost of the system has enabled Thorn to capture a part of this market. However, there is little scope for improving the facilities offered on the VHD system and industry observers do not expect that the system will ever be used for mainstream storage of digital information.

This leaves optical systems based around the use of a laser beam for both recording and playback and these form the basis all the other videodisc, compact disc and digital optical disk systems on the market. All the optical videodisc systems which have been launched in the past five years make use of a mastering technique developed by Philips which we shall briefly describe here as it is used for the creation of all optical disc systems. All that basically differs is the amount and type of material that is recorded onto the master disc and the type of coatings placed on the replicate discs once they have been created.

Videodiscs, at present, are read only publishing media and hence all the information has to be recorded onto the master disc at the production stage. The user has no recording facilities - he will only have a playback unit. By contrast, with recordable and erasable rerecordable digital optical disk systems, the only information that needs to be recorded onto the master disk is the basic formatting and indexing data - the rest of the disk is left blank for the user to record his own data onto it.

Similarly, with read only videodiscs, once the replicate discs have been stamped out, all the supplier needs to do is appiy a protective coating and package them ready for distribution. With recordable and erasable / rerecordable disks, the supplier has to coat the blank formatted disks with layers of recordable media prior to applying a thinner protective layer which can be penetrated by the record laser beam in the user's digital optical disk drives. The chemical content and the thickness of the sensitive recordable layers varies from supplier to supplier according to whether the disk is write once or erasable.

For videodisc mastering, the program information, which can be stored on film or tape, is read by a helical scan videotape unit and used to modulate the intensity of a laser beam which is focused on a rotating glass master disc which is coated with a thin film of photoresist. Once recording is complete the exposed areas of photoresist are etched away to leave a master disc containing video information encoded in its periodicity and length as pits. The master's recording surface is then metallised using an evaporated coating and becomes the source for generating identical submasters which are then used to produce stampers which are used to produce hundreds or thousands of identical copies of the master videodisc for distribution to users with videodisc players and television monitors.

The information can be recorded on the discs in two different ways, to cater for two different markets. For the consumer market, where all that is required is the serial playback of feature films etc., the chief aim is to provide the maximum playback time per disc side. Hence Philips

abandoned the principle of one video frame per revolution of the disc and varied the velocity of the disc to give contant linear velocity (CLV) mode or long play disc. This involves expanding the playback time of each side of the disc by placing two or even three frames on the outer track of the disc where the circumference of the disc is greater and one frame on the inner, shorter tracks. The result is that a 12 inch CLV videodisc can hold 60 minutes of video on each side - a total of two hours per disc.

The alternative mode is constant angular velocity (CAV) mode or active play where one frame is allocated to each track and the disc rotates at a constant velocity with linear tracking velocity increasing from the innermost track where it is least to the outermost track where it is greatest. As each track holds one video frame, a single frame can be frozen on the screen by directing the laser beam read head to scan one track continuously and the speed and direction of the read head can be exactly controlled and each frame on each disc (54,000 per side) can be numbered and the read head required to go and read any one at speeds measured in fractions of a second. The CAV discs have proved extremely successful in interactive training and point of sale (POS) type systems and a hierarchy of players and systems have evolved. Level 0 players offer basic serial play facilities; Level 1 players offer additional still frame, forward and reverse play facilities under remote keypad control; Level 2 players have their own internal microprocessor controllers and hence can be programmed to display frames in a set sequence; Level 3 systems comprise a Level 2 player connected to and controlled by a computer system and Level 4 systems are also available now with a number of players controlled by a computer and range of graphic overlay and simulation facilities.

Hybrid Discs

Hybrid discs or hybrids are those videodiscs which are used to store digital data in analogue form or, more usually, a mixture of digital data and analogue information. Given the figures listed above for CAV videodiscs, it was not surprising that a number of companies should investigate the potential of standard videodiscs for distributing digital data. There are very few limitations placed upon the type of signal which can be stored on a videodisc as the channel is clean and wideband. Any signal which can be segmented for the insertion of TV-type synchronisation bursts and which fits within a 4.2 MHz 40dB band can be recorded onto a videodisc and recovered by a standard player and some form of outboard decoder e.g. digital data, audio and very high resolution video. Digital data can be impressed on the lines of a composite video frame as well as analogue video signals. In theory some 400 bits can be written on each TV line and with approx 500 lines per frame, one frame per track and 50,000 tracks per side that gives a theoretical storage capacity of at least 1 Gbyte of data per side - making the videodisc a potentially low cost, high density data distribution media.

The development of a range of different techniques for encoding digital data onto standard videodiscs by a number of US companies including Laserdata, Reference Technology and TMS allowed a number of publishers and database providers to take their first tentative steps into electronic publishing. Provided the publisher had the material in machine readable form, all he had to do was send it in half inch magnetic tape to one of the above companies and they would encode the data, record it onto a master videodisc, stamp out replicate discs containing the data and provide the publishers' clients with the relevant hardware and software needed to read the data back from the discs.

One problem with these hybrid videodisc based information delivery systems was a lack of standardisation. All three companies used proprietary encoding techniques and different

hardware at the workstation with the result that a TMS videodisc could not be played back on a Laserdata workstation etc. Laserdata themselves offered the end user a workstation which comprised an industrial videodisc player linked to a decoder/controller which was in turn fitted in a microcomputer. The user searched the data via the keyboard on the microcomputer, the data was read off the videodisc, converted in real time from analogue to digital format, passed through an error detection and correction system and then displayed on the computer terminal. Reference Technology, on the other hand, opted not to use a standard videodisc player and developed their own Datadrive 2000, a high specification drive with millisecond access speeds, integral error detection and correction (EDAC) system and a number of outlet ports so that it could be accessed by multiple users at their own microcomputers.

A second problem was the relatively high price of the hardware. The Laserdata end user workstation, comprising a standard videodisc player, the controller and an IBM PC would cost approx £8,000 and could only be used by one person at a time.

These two factors - the lack of standards and the relatively high price of the hardware - have tended to restrict the number of applications where hybrid systems have been used. Hybrid systems are not generally popular with generic publishers who are looking for a standard medium like paper or microfilm that everyone can access. However, they have been used by a number of specialist information providers who have a closed user base so they can opt for one particular system and major on it. One major advantage of hybrid systems is, of course, the ability to store a range of different types of information on one disc including coded text, raster scanned images, video still frames and moving sequences and audio information.

Recently, a major new player in the hybrid arena has been Philips themselves, with their so called Laservision ROM system which is a new generation Laservision player, which can accept discs holding the standard 54,000 frames of video on each side plus a further 324 Mbytes of digital data per side. The data is encoded in the low band part of the signal which is not required for video or audio and the player will be able to read back both the video and the data and display the data on a computer terminal and the video on a video monitor. The product had not been finally launched as we completed this report but one of the first products to be launched on Laservision ROM will be the much heralded BBC Domesday Project videodiscs. These will include a mix of still frames of photographs, maps etc. from throughout the UK plus data containing statistics, descriptive text etc. The Domesday discs will provide a unique source of reference material and it is hoped that libraries, schools and businesses will purchase the necessary hardware to play back the discs. More details of the Domesday Project can be found in chapter two.

Compact Discs

Compact discs (CD's) have been available in Japan since 1982 and in Europe since 1983, a considerably shorter time than consumer videodiscs, but already they are having a much greater impact with sales of compact disc players measured in the millions and new players arriving on the scene on a weekly basis. Compact discs are designed to compete with gramophone records and audiocassette systems for a share of the lucrative consumer hi-fi market. Currently, CD systems are all standardised on the format and digital recording techniques designed by Philips and the error detection and correction systems jointly developed by Philips and Sony. As with videodiscs, production of a compact disc is basically a three stage process involving premastering, mastering and replication of the discs. Premastering involves the recording of audio information onto digital tape to provide an input to the mastering process. Mastering

involves transferring the information stored on tape onto a master compact disc and replication then involves the creation of several stampers or submasters from the master and the production of large volumes of replicate discs from these sub-masters.

The most significant fact about compact discs is that the audio information is digitally coded prior to storage on the discs and is read off the discs as a bit stream at rates in excess of 4 Mbits per second. In other words, the compact discs are storing digital data just as magnetic disks store digital data, the difference is that with compact discs the digital data comprises information about a series of audio signals and at the output stage it is passed through a digital to analogue converter for output as a series of audio signals which can be replayed on consumer hi-fi systems making use of the same amplifier and loudspeaker systems as would be used to replay the signals picked up from a record deck or audio cassette system.

Compact discs have a run-in section, a music section and a run-out section, all of which contain information in digitally encoded form. In the run-in section there will be a table of contents plus details of the number of recorded tracks and the time from the start of the disc to each track. Data is actually recorded onto each CD in a spiral of tracks on a 1.6 micron track pitch starting at the inside of the disc. The standard 12 cm diameter disc contains some 20,000 spirals in the programme area and in these are recorded a series of laser cut pits 0.6 microns wide and in 8 different lengths. Currently, using this recording method, one side of a CD can store over 60 minutes of high quality stereo which represents approx 5 Gbits in digital form or, when EDAC codes are added in, a total storage capacity of 7 Gbits.

Playback, as with videodiscs, is via a laser optical system which has to be accurately positioned over the relevant track and focused on the disc's recorded surface. In operation, the intensity of the reflected laser beam is less when the laser reads a pit than when the laser reads a land and the reflected light is detected by photocells and constitutes the raw digital signal. The discs are played back at constant linear velocity (CLV) of 1.25 m/sec from the inside to the outside which means that the rotational speed varies from 430 to 200 rpm. Error detection and correction is handled at the encoding stage by adding redundant data and is carried out within the drive.

The above description should give some indication of just what a sophisticated piece of equipment the CD player is. When first introduced, CD players were priced at £ 800 but already high sales and strong competition has led to the price dropping below £ 200 and many predict that we will soon be seeing the £ 100 CD player in the shops. The advent of 'in car' CD players and CD portables will ensure continued growth in the CD market and many predict that it will be the dominant audio medium by 1990. As with consumer videodiscs, it was not long after the launch of CDs for audio that computer companies and database providers began to assess the potential of CD for data storage and distribution and the result - the CD ROM (compact disc read only memory) is described below.

CD ROM (Compact Disc Read Only Memory)

CD ROM systems are basically a direct adaptation of the CD system for publishing and data processing applications. The worldwide standards which had been established for CD in the Philips / Sony 'Red Book', were extended by Philips and Sony in their 'Yellow Book' to cover the requirements of the data processing environment so CD ROM drives and discs benefit from the use of proven technologies and from the economies of scale which have resulted from the rapid success of CD systems in the consumer market.

Since CD ROM discs have been designed to be compatible with CD audio discs, the same

basic CD player can be used for both music playback and data retrieval in the domestic market and already a number of combined audio/data CD ROM players have been launched. The combined players have two inputs - in the case of CD audio the output goes via a digital to analogue converter and from there to the amplifier and loudspeaker system. With CD ROM the digital data on the disc is transferred directly to a computer or an output device such as the monitor or printer.

The data format is the same for both consumer and professional applications and the disc mastering and production facilities which are already well established for the CD audio system can be used to produce CD ROMs as well. The only process that differs is the premastering required to produce the master tape.

Data to be recorded on CD ROM is sent to a premastering facility on standard magnetic tape. The data is then processed to split it into 2 Kbyte blocks to which synchronisation patterns, headers plus EDAC codes are added in order to form CD ROM sectors of 2352 bytes. During recording the information is encoded into the CD format and the mastering and replication process then follows as for CD audio. A CD audio disc contains up to 99 audio tracks and these can easily be replaced by the same number of data tracks on the CD ROM and for retrieval the user selects the track and number of bytes required. Alternatively, since the whole 600 Mbytes are in one continuous stream, the user can request a particular byte number to start and the following X bytes. Finally, since CD ROM data is organised sequentially along a spiral and read with CLV they are addressed in absolute time. The total time is that needed to read the data sequentially and this is subdivided into 0 - 60 minutes, 0 - 59 seconds, 0 - 74 fractions of a second. A microprocessor head than interprets these time instructions via a simple time/position algorithm to give fast, random access. CD ROMs, like CDs, are single sided 12 cm diameter discs and the total user storage capacity is 600 Mbytes. CD ROM is, as its name implies, a read only medium and it is not, therefore, intended to replace any of the current magnetic storage media but rather to provide computer users with a low cost, high capacity, durable mass data distribution medium.

The first drives to be shown were modified consumer CD players but already compact 5.25 inch drives have been shown, which can be fitted into the form slide of a PC and replace the flexible diskette drive. The Philips CM 100 drive offers a storage capacity of 600 Mbytes, average access time of 1 second and maximum access times of 2 seconds for each seek. The data transfer rate from the CD ROM drive to the PC is 1.41 Mbits/sec using a proprietary high speed serial interface. The standalone drive measures 115 mm (h) x 320 mm (w) x 267 mm (d) and weighs approx 5 kg.

Currently the cost of mastering one CD ROM (assuming the data is already available on tape in the required form) is approx £ 3000 and the cost of replicating the discs is £ 10 - 17 per disc, depending on whether or not the run is for hundreds or thousands of replicates. By 1990 it is predicted that mastering costs will have dropped to £ 1000 and replicates will cost £ 1 in high volume. Turnaround time from receipt of tape to despatch of replicate discs is 2 weeks but as capacity grows this will come down to under a week in urgent cases.

CDI (Compact Disc Interactive)

As we were writing this report Philips and Sony announced a third type of compact disc systems which they are calling Compact Disc Interactive and which looks destined to have a major impact on the domestic publishing market. The final specifications of CDI will be laid

down in the 'Green Book' and were still to be determined as we finished this report but we include here a basic outline of CDI and indicate where it fits into the hierarchy of optical read only memory systems.

CD audio systems are primarily aimed at distributing audio information to domestic users and all conform to the Philips/Sony world standard (the Red Book) so any CD audio disc can be played on any CD player worldwide. The Philips/Sony standard covered both hardware and software. The hardware element covered aspects of the players and the software covered the way the audio information was recorded onto the discs and mastering companies and record producers licenses which enabled them to produce players and compact discs which met the standard and there are now some 50 - 60 licensees worldwide.

CD ROM systems represent an extension of the use of CD audio for the distribution of text and Philips and Sony laid again down the physical standards (in the Yellow Book) governing how data should be recorded on the discs etc but Philips and Sony did not go so far as to try and standardise the logical file formats or, in other words, the order in which the data should be recorded on the disc, how it should be structured, file sizes, directory locations etc. They decided that this was best left to the users as software companies, computer suppliers etc who would then be free to develop their own data structures on the discs, just as they have done with flexible diskettes and Winchester disks.

However, as we have shown above, it became very clear to both computer companies, software suppliers, publishers and end users, that one of the main market for CD ROMs was not just software distribution to individual computer systems, but as a generic optical publishing medium and for this aim to be achieved, there was a need to try and standardise file formats at a basic level so CD ROMs which met this standard could be readable on a number of drives linked to a number of computers. To this end a number of standards committees are meeting in the US and Europe to try and determine the basic requirements of such a standard and as we completed this report a Level One standard was expected in May 1986 which would cover the recording of data and text on CD ROM.

This should meet the needs of publishers who wish to distribute databases and full text directories and reference works on CD ROM to professional end users and libraries with CD ROM drives linked to microcomputers such as the IBM PC XT, AT and compatibles and the DEC MicroVax. However, it does not address the domestic market for CD ROM where users cannot be expected to have powerful business microcomputers installed.

Compact Disc Interactive is Philips' attempt to provide a packaged CD ROM systems geared primarily to the needs of the domestic market. Just as the CD audio standards addressed the hardware, the media and the formatting of the information on the disc, so that the CDI standard (laid down in the 'Green Book') will address hardware, media and data formatting requirements, providing player manufacturers, disc mastering facilities and publishers aiming to publish information an CDI with a complete set of guidelines which, provided they follow them, will enable any CDI to be playable on any CDI player.

As a consumer product, the main difference between CDI and CD audio is that wheras CD audio discs and players can only hold and playback audio information, CDI discs and players can hold combinations of audio, video, text, data and computer programs for interactive operation on essentially self-contained players. Just as with CD audio, Philips and Sony will make the hardware and software standards for CDI available to companies applying for a

licence and they clearly hope that all the companies currently holding licences for CD audio and CD ROM player and media production, will also apply for CDI licences.

We would stress that at the time writing this report, CDI had only just been announced and no players or CDI discs had been demonstrated but the standard is being shown to CD audio and CD ROM licencees and Philips expect it to be announced in detail by the end of 1986 with hardware and discs appearing in 1987. There will be two hardware configurations. Firstly, it will be possible to use recent and future audio CD players with a direct digital output to play both CD audio and CDI discs. For CDI discs an additional CDI unit will be attached to decode the information read-out from the disc for replay of CDI text and visual information. Reproductions of pictures, graphics and animations can be via the user's TV set for a normal replay quality level or through a separate dedicated colour monitor.

In addition, Philips and their licensees will provided dedicated CDI players which will also be able to play current CD audio discs and new CDI discs. They will contain all the necessary control facilities activated via a built-in keypad or remote control unit and will be connectable to existing audio and video equipment. Where the user has a personal computer it will also be possible for this to be connected to the CDI player and used to control the access to text and data. However, such a connection will not be strictly necessary as the CDI player will contain its own 68000 series processor plus dedicated hardware so users would be able to search and retrieve records from a total of over 600 Mbytes stored on the CDI - just as they could do today via a CD ROM drive linked to a microcomputer.

The packaged nature of CDI and the greater degree of standardisation should make it very attractive to publishers who would not need to worry about what hardware the user had. They would simply follow the guidelines laid down by Philips.

The price of a CDI player should be approximately £ 300 - 400 and Philips expect them to be sold in retail outlets alongside CD audio players. Typical costs for producing and mastering a CDI which made use of all the graphics, audio and data facilities would probably be close to those of producing an interactive videodisc today - approx £ 50 - 100,000.

Clearly, CDI will have a major impact but exactly where cannot be predicted at this stage. We would expect to see CD used for audio distribution on cost grounds, CDI used to distribute dictionaries, encyclopaedias, educational material, cartoons, video games etc to the home market and also, to schools, libraries and some sectors of business where hardware costs and simplicity of operation are critical factors. CD ROM, on the other hand, will be used to distribute large valuable textual databases to PC users for local processing as indicated above. It is quite likely, at this stage, that the Level One standard for CD ROM file formats, if agreed, will coincide with that aspect of the Philips/Sony CDI standard which relates to the recording of text and data on CDI.

The only negative aspects of CDI are that it comes at a time when publishers, computer companies and software suppliers had began to make a substantial investment in CD ROM systems and it may have the effect of causing many of these companies to hold back and reassess the options open to them.

OROM (Optical Read Only Memory)

OROM is the acronym for the final optical read only memory system that we are going to

consider here. Unlike videodiscs, CDs or CD ROMs, it is not commercially available at present but it has been shown in prototype form by 3M who are promoting it as part of their push towards a universal optical disk drive which would be capable of accepting read only, write once and erasable disks. The OROM has a diameter of 5.25 inches or 13 cm and hence is modelled on the standard Winchester disk format. Also, unlike CD ROM it is a dual sided medium and it is a CAV mode or active play disc wheras CD ROM is a CLV mode disc. Beyond this it is not possible to give detailed specifications as 3M have not yet issued them but the OROM is expected to have a storage capacity of 250 Mbytes per side (considerably less than CD ROM) and average access times of 100 ms (considerably faster than CD ROM).

3M have reached agreement with Optimem whereby 3M will produce the OROM discs and Optimem will produce a universal 5.25 inch drive capable of accepting OROM plus write once and erasable disks when they become available. However, the drive is expected to cost £ 1,500 - 2,000 and the OROM media will be more expensive than CD ROM. It is hard to see, at this stage, how OROM could compete with CD ROM as a publishing medium - either on cost grounds or on storage capacity - but the fast access speeds and the universal nature of the drive could make it attractive in the office automation field for the distribution of software etc.

Digital Optical Disks

Wheras all the above disc systems have been read only systems for publishing applications, digital optical disks function as both masters and duplicates in that each disk can be recorded on and read back using one multifunction record/playback unit or drive. The user with a digital optical disk (DOD) drive installed inhouse can record data onto the disk and go on adding data until the disk is full. However, any one sector of the disk can only be recorded on once and when the sectors are full up no more information can be added to the disk. Because the data is recorded on the disk as a series of pits or bubbles in the surface it is not possible to erase or rerecord sectors of the disk as one can with magnetic disks. Hence these first generation digital optical disks are also known as write once optical disks (WOODs). This write once characteristic makes DODs an ideal medium for archival storage of both computer data and digitised document images and it is currently being evaluated as a conservation tool by a number of national libraries including the Library of Congress.

The processes involved in producing recordable digital optical disks (DODs) are very similar in many respects to those for read only media but there are also a number of key differences which restrict the potential of recordable disk systems for publishing applications. At the mastering stage, only the formatting and indexing data is recorded on the DOD, leaving the rest of the disk blank for users to record their own data onto it at a later stage. After mastering, the blank formatted disks are stamped out in the same way as read only disks but instead of simply being coated with a reflective layer and a protective coating - as is the case with CD ROMs and videodiscs - the recordable disks are firstly coated with a sensitive recording layer and then a number of different protective treatments are applied and the replicates are usually loaded into plastic cartridges to provide further protection from damage during handling.

Then, at the playback stage, users of DOD systems require a combined recorder/player rather than just a simple player and there are no read only drives available at present for DODs. In the recorder/player or drive, the optical read/write head comprises either two separate lasers - a relatively high power laser for recording and a lower power laser for reading - or one laser which can operate at different levels of intensity for both reading and writing.

One further key difference is that while there is one physical standard for videodiscs, CDs and

CD ROMs, there is no standard for DODs at present and hence there are a wide range of disks of different diameters and using different substrates and recording techniques etc and a range of proprietary drives and disks from one supplier cannot be read on drives from another supplier except in certain cases. The exception is Alcatel Thomson, the French supplier of disk drives and media. Their disks can be read on their own drives and on drives from Optimem in the US. In addition, 3M and Hoechst also make media that will be readable on the Alcatel Thomson Gigadisc disk drive and the Optimem 1000 disk drive.

The first generation of digital optical disks were all 12 inch diameter disks based on the consumer videodisc standard and although the techniques employed varied widely, most disks had a storage capacity of 1 - 1.3 Gbytes per side. The basic specifications are best illustrated by reference to one specific example - the OSI (Optical Storage International) Laserdrive 1200 DOD drive. This accepts single or double sided 12 inch DODs with a storage capacity of 1 Gbyte per side. There are 32,000 tracks per disk with 32 sectors of 1024 user bytes per track. The drive can be supplied with an ISI or SCSI interface and offers a sustained data transfer rate on the host of 250 Kbytes/sec. Average access time is 150 ms and the disk rotates at 480 rpm. Corrected error rates from the drive are less than 1 in 10,000,000,000 and the drive weighs 25 kg and measures 133 mm (h) x 483 mm (w) x 650 mm (d).

A new generation of 5.25 inch recordable DOD drives are also now being introduced by companies such as ISI, Optotech and Optimem - the latter as part of their 5.25 inch universal drive project with 3M. The 5.25 inch disks have storage capacities from 1 - 400 Mbytes per side.

The recordable disk media are more expensive than the replicated read only discs and costs are £ 2-500 are quoted at this stage for each disk. The drives are also relatively expensive at approx £ 10,000, underlining that DOD drives are aimed at the computer storage peripheral market and not the distributed publishing market.

The two main applications for DODs are for the archiving of computer data where they are already beginning to challenge magnetic tape drives, and as a storage subsystem in future document image storage and retrieval systems. As a computer data storage medium, DODs offer higher density storage, durability due to the use of non contact laser record and read heads and fast access times.

In electronic document storage systems, incoming paper documents such as journal articles, medical records, product literature etc will be scanned and digitised using charge coupled device (CCD) arrays which operate like office facsimile machines. The text or graphics contained on a page are converted into a digital bit stream which can be stored on specific sectors of a DOD, indexed and then retrieved automatically on request and transmitted to a user workstation for display or printout. Such systems offer fast document capture, direct read after write, multi-user access and a number of other facilities and will begin to replace microfilm based systems in large national libraries and in special and academic libraries where press cuttings, trade literature and specialised collections could be built up in this way. We analyse the potential of these systems for publishers building up inhouse databases and for special libraries in the following chapters of this report.

Erasable Digital Optical Disks

While write once DODs allow users to record data onto DODs inhouse until they are full up, erasable rewritable DODs will allow users to record, erase and rerecord data on the same

sector of the disk many thousands of times without any significant deterioration of the signal. Hence, while write once disks will primarily be used as long term storage medium for computer data and scanned document images, erasable digital optical disks will directly challenge the existing range of magnetic disks. In their favour, they will offer high storage capacities of up to 500 Mbytes on a 5.25 inch disk, relatively low cost of media and drives (approx the same as for write once systems), removability so one drive can be used to play a large number of disks and durability due to the fact that they will be recorded and read by a laser beam so there is no danger of head crashes etc.

As with write once digital optical disks, a range of different recording materials and techniques are being experimented with but two recording techniques have attracted particular attention. The first involves the use of tellurium based amorphous to crystalline phase change materials. Phase change systems are based around the fact that certain tellurium based alloys can exist at room temperature in either the crystalline or the amorphous form and can be switched reversibly between each state. The optical properties of the film - its reflectivity - are different from the crystalline and amorphous states and this forms the basis for the optical read out of the stored data. Matsushita are one of the furthest advanced in this field and have shown disks that can be recorded on and erased over one million times without degradation.

The second technique is called magneto-optic recording and appears to be the most favoured at present with companies such as 3M, Sony/KDD, Sharp, Canon and others showing prototype systems and supplying media to OEMs and drive manufactures. Magneto-optical disks comprise a base made of glass or PMMA on which is laid a layer of reflective material, a layer of dielectric material covered with magnetic film on which data is recorded and finally a layer of protective coating. The entire recording layer of the disk is perpendicularly magnetised before recording takes place then, at the recording stage, a micron sized region on the disk is heated by the write laser to a point above the Curie temperature and as the material cools in the presence of an external magnetic field oriented antiparallel to the initial direction of magnetisation, a small region is formed that is reverse-polarised. Playback is based on a magnetic light polarisation phenomenon where the plane of reflected light is determined by the direction of magnetisation. For reading, a lower power laser beam pinpoints the discrete location and reflective analysis is used to determine the magnetic state of the recorded magnetic bit. When information is erased individual bits are reversed using the same mechanism as for initial recording.

The first generation of erasable DOD drives and media are expected to be made available commercially in late 1989, early 1990. The processes involved in mastering and replicating erasable DODs are almost the same as those for recordable DODs. The mastering stages are the same and much of the replication, but at the coating stage the chemical structure of the recording layer is different so that the recording/erasure process can be repeated on a cyclical basis and not be a single unalterable process.

Optical Cards

So far in this review of optical storage systems coming onto the market we have only looked at disk systems and there can be no doubting that disks will be the dominant format due to their ability to support fast random access to information stored upon them. However, there will be certain applications where, for reasons of cost or portability, disk will not be the ideal format and the same optical storage media will and is being made available on credit cards and in tape format.

Drexler Technology Corporation have pioneered the concept of simplified compact and low

cost laser optical memory cards for such applications as software loading, data recording, transaction recording, electronic publishing and information storage. The Drexon laser cards involve the use of concentrated laser energy or photolithography to record patterns of extremely small spots representing digital information. The Drexon data strip encapsulated within the cards comes in two widths - 16 mm or 35 mm - and can be read using low cost optical systems. Lasercard systems can be both compact in size and simple in design because a small semiconductor laser and charge coupled device (CCD) array can be used for writing/reading. Drexler produce both read only and write once laser cards. Currently the storage capacity is 2 Mbytes per card and the cards should sell for 2 dollars each in volume.

To date Drexler have over 20 licensees including, in the publishing sphere, Pergamon Press / BPCC; Gakken Co and Computer Services Corporation and the cards are already being used in one major application in the US to hold medical records of clients to a major medical insurance company.

A number of readers and read/write units have been shown which attach to the IBM PC and one of the major applications for the optical cards is expected to be the distribution of games software and other software aimed at the home computer user plus the distribution of financial reports and regularly updated material. The write once cards could be used to record financial transactions on credit cards and library loans etc on library cards.

Optical Tapes

The final area where laser optical storage media could play a role is as a very low cost, serial access archival medium for computer data - namely optical tape. Drexler have shown optical tape subsystems and so too have a Dutch company called Docdata. Drexler have shown a number of different sizes of tapes all offering a write-once, read many times facility. They showed a 2,400 ft length of 70 mm optical tape which had a storage capacity of some 50 Gbytes. At the other end of the scale, they have also shown 3 mm wide optical tape in 25 ft lengths with a storage capacity of 25 Mbytes. A standard optical tape product designed to compete with magnetic tape would have the advantage of low cost, high durability and higher storage capacity but it would still only offer slow serial access so most observers feel that write once disks will restrict the market for optical tape systems.

Docdata have developed a mass data archiving system based around the use of digital optical tape cassettes with multi-track optical read/write heads and a matching optical film with a three dimensional structure. Their first commercial product is expected to be a mass storage device called a Doc Wheel which will store the equivalent of five thousand eight hundred 2400 ft reels of 6250 bpi magnetic tape and make it available online without any need for operator intervention. The tape used in the Doc Wheel can be written on and read by a laser beam and is non erasable.

Summary

In this survey of optical storage media we have shown how the combination of laser write/read heads and sensitive recording layers has led to the development of a wide range of read only, write once and erasable/rewritable storage media with enormous storage capacities and other potentially significant benefits over existing magnetic media and microfilm including durability and fast access times. While the different optical storage systems have been designed to serve different markets, they share many characteristics in common and this will lead to

significant economies in the production of both the media and the drives they play on. Already the read only products have proved successful and the signs look very promising for systems based around write once and erasable disks too.

We hope that the above survey and the table reproduced below will clarify the situation for those readers who are new to this field as a basic grounding in the technology is essential if we are to see the potential of these optical storage systems in the publishing and library and information worlds.

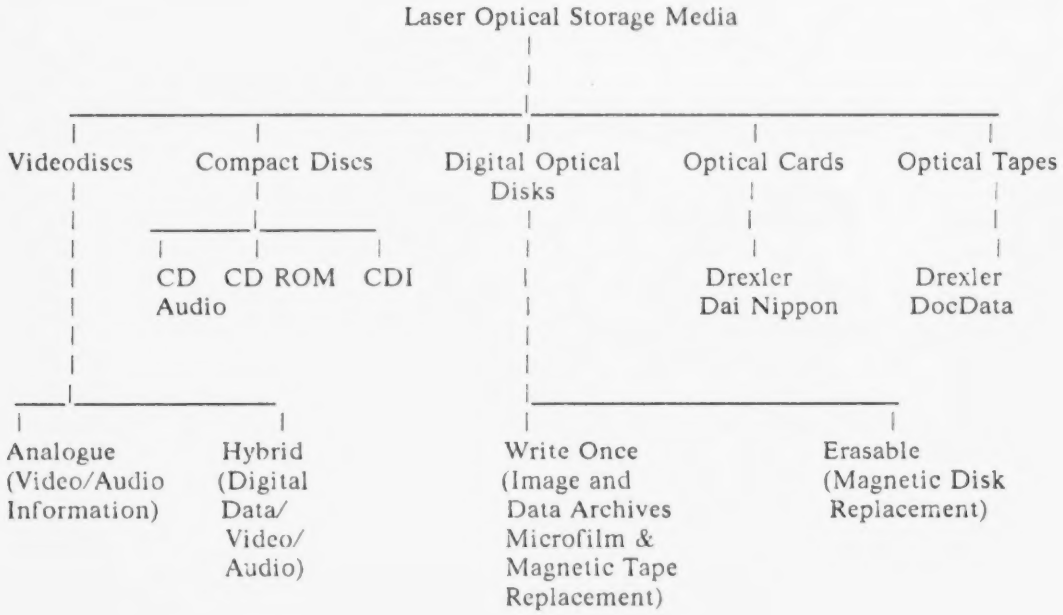

Table 2

Chapter 2

Applications for Optical Disk Systems in the Publishing Field

Introduction

The term 'publishing' encompasses a wide range of activities today and needs some further definition before we go on to consider how appropriate certain optical storage systems are to particular publications. We would tend to break the publishing field up into three major subdivisions which we here label as 'inhouse publishing'; 'technical publishing' and 'commercial publishing'.

By 'inhouse publishing' we mean systems for assembling, ordering and disseminating information within a company or government department etc. Today these normally involve the use of inhouse reprographic units or commercial print shops to print reports, telephone directories, sets of statistics, minutes of meetings etc which are then distributed to a list of people within the organisation who need to receive that information. While paper is still the most popular medium for distributing this inhouse information, many organisations also use computer output microfiche (COM) and some use online electronic distribution via PC networks etc.

Technical publishing systems overlap with inhouse systems and may be run inhouse in some instances. Typically, they involve the capture, manipulation, storage and dissemination of technical documentation - parts lists, instruction manuals, specifications, standards, pricing information, maintenance schedules etc. One significant difference between technical and inhouse publishing systems is that the resulting technical manuals, parts lists etc are usually sent outside the originating organisation to a controlled set of users - e.g. dealers for automotive manufacturers, retailers for manufacturers of a wide range of electrical and mechanical products, branches of banks, building societies etc. Hence technical publishing is nearer to traditional publishing than inhouse publishing in that the technical publisher is often aiming at an external audience. However, that audience, in the case of dealers etc, is often a captive one and can be relied upon/ instructed to have certain standard hardware items needed to access the published information - e.g. a microfiche reader, a specific computer terminal or, in future, perhaps a CD ROM player linked to a specific computer.

Again, the technical publisher has a choice of publishing material on paper, microfiche or via an electronic distribution network. As the information usually needs to be more up-to-date than with inhouse publications, there has been a greater use of microfiche and online systems here.

The third, and more traditional area, is that of commercial publishing where the publisher identifies a market for a particular publication or information service, produces it, makes it available in the most appropriate form and then proceeds to market it via established channels to his perceived market. This area of commercial publishing can, of course, be further subdivided into areas such as scholarly publishing; scientific publishing; educational publishing; reference/information service provision via directories or online database systems and, finally, general publishing which includes the provision of works of fiction and so called 'coffee table' books.

In this chapter we will be mainly concerned with this third category of commercial publishing

but we will draw on examples of applications in the other two categories where appropriate to illustrate the potential of one or other optical storage system. The reason for this is not because we do not see applications for optical storage systems in inhouse and technical publishing - there are many - but because we wish to concentrate on those applications which will be most likely to affect libraries in their role as purchasers of published information and the majority of the material that libraries purchase is, necessarily, in the third category of commercial publications.

Videodiscs

Videodiscs were developed initally as a consumer product to enable people to playback feature films etc on their television sets. In other words they were used to publish video material and audio material. In the event, due to the widespread availability of video cassette recorders and the lack of a record facility on videodisc players, they did not prove successful in this market. In the future the development of low cost combined Compact Disc and Videodisc players may lead to a resurgence of interest in videodiscs as a consumer product but with CD audio systems selling well now and CD Interactive systems poised to enter the market and offer many of the facilities of a full interactive videodisc system at a fraction of the cost, we do not expect to see much activity in the consumer videodisc area over the next few years.

However, the high storage capacity of the videodiscs, the random access facilities, the ability to freeze frames and display them continuously and the ability to control the retrieval of videodisc frames via a keypad or by a computer program, has led to a number of other major applications for such interactive videodisc systems in the training, point of sale and public information areas. The production of an interactive videodisc based training programme is an expensive venture and there are problems in terms of compatibility of players etc when one begins to use videodiscs interactively. If all one wants to do is record a feature film on a videodisc and play it back then the same videodisc can be played back on any Laservision standard player, whether it is made by Hitachi or Pioneer or Philips. However, when one wants to create a computer program that controls the videodisc player and retrieves frames in a certain sequence then immediately you have to start to specify which computer the program is designed to run on and which player it is designed to control because different players will require different commands etc.

Because of the cost factors and the hardware compatibility problems, the majority of interactive videodisc systems that have been installed to date have been installed in one major company or in a chain of retail shops owned by one company. Classic examples are the automobile industry where General Motors have installed videodisc players in all their main dealers in order to train mechanics and sales staff, and the banks where Lloyds have also installed a large network of videodisc players for use in training staff. Large companies such as these can decide to purchase players from one manufacturer and standardise on those so compatibility is not a problem for them as long as they can ensure continuity of supply.

When it comes to trying to make generic material available on videodiscs and publishing it for use by all schools or all libraries or museums etc then the compatibility problem arises again because it is more difficult to ensure that all the schools will have the right players or the right computers to run the program. However, there have been some examples of publishing generic courseware on videodiscs and many such projects are currently under development.

One approach to the publishing of interactive videodisc courseware is to sell the hardware and

software together as a package or to hire the hardware out for set periods. Digital Controls have adopted this approach with their 'Learning Centre' which comprises an industrial videodisc player, a computer terminal and a reprogrammable memory cartridge (EPROM) which delivers the system control. The courseware consists of a videodisc, an EPROM and a course manual. The Learning Centre has been designed to help users of PC's to learn how to use a range of software and operating systems. It is aimed at businesses with PC networks, PC dealers and educational establishments. To date there as eight courses available including an introduction to the IBM PC; an introduction to MS/PC DOS; Wordstar etc. In the UK companies can purchase the hardware for £ 5,000 or hire the system for £ 50 per day. Each software package costs a further £ 750.

In a project geared more to the needs of schools, Futuremedia and John Wiley and Sons have produced 'The Science Laboratory Videodisc'. This is an interactive videodisc system which has been designed to play on a Laservision industrial player and the BBC Model B microcomputer which is widely available in schools and will allow the user to conduct experiments using the computer keyboard or a light pen to control the videodisc images.

The third option is to simply supply a database of visual material on videodisc which teachers and others can then use to construct lessons or sequenced displays by programming a sequence of frames for display etc. In effect, then, the videodisc would be a large slide bank.

Hence, there are currently three options in videodisc publishing at present - to supply the hardware and software; to supply the videodisc plus computer software or to just supply the videodisc. In the future we would consider that the arrival of the Compact Disc Interactive standard, provided it is taken up by the most of the existing CD licensees, will largely usurp videodisc's fledgling role as a publishing medium.

CDI players, with their own inbuilt microprocessor, will take over the role of both the videodisc player and the control microcomputer so publishers will not have to worry about which computer their program is going to be running on. A publisher will produce a CDI disc with data, video, audio and software on it and providing it has been produced to the Philips/Sony standard it will play on any CDI player. Publishers looking to produce generic software on videodiscs and sell it to the educational, library or domestic market would therefore be well advised to hold back and look at the potential of CDI. In future we feel that videodiscs will remain in training and point of sale systems but CDI will dominate in the generic publishing market.

Hybrid Discs

With the standard analogue videodisc systems describes above, publishers were very limited in the amount of text they could display on any one frame or screen. The limitations of a standard video camera and a standard television screen meant that it simply was not possible to point a video camera at a page of text, store it as a frame on one track of a videodisc and display it on a screen. - it would not have been legible. Hence most interactive videodisc systems confined themselves to displaying poster type frames with a relatively few lines of text on each one.

The development of techniques for encoding digital data into the video signals of the videodiscs, however, meant that word processing text and other data could be stored on these hybrid videodiscs and retrieved and displayed a screen at a time and this allowed publishers to

use hybrid videodiscs to distribute purely textual databases or to distribute mixed mode or hybrid databases comprising coded text plus still frame video or video sequences and audio information. Hence, in theory, encyclopaedias could be distributed on hybrid discs with text, pictures, video sequences and audio commentary.

The problem was that there were a number of proprietary recording techniques again and users needed to purchase specialised hardware to playback the hybrid discs so again hybrid systems did not lend themselves easily to generic publishing applications - they were confined to specialised publishing activities where a publisher would use one system inhouse or provide his customers with the necessary hardware as part of the subscription. There was the added problem too, of continuity of supply as many of the companies supplying the specialised hardware were small start-up companies with little track record.

Recently, however, Philips have issued preliminary information about their Laservision ROM hybrid system which will enable them to store 54,000 video frames plus 324 Mbytes of data on one side of a 12 inch videodisc. The BBC have already based their Domesday videodiscs around this format and an Esprit funded project is making use of Laservision ROM as well so the feeling was that this could become the de facto standard for hybrid discs and if sufficient schools, libraries etc were to invest in the hardware needed to playback the Domesday discs then other generic publications could follow, aimed at the installed base of Laservision ROM users. Again, with the advent of CDI, offering many of the facilities of Laservision ROM (but less storage capacity) at lower cost and in one packaged piece of hardware, the likelihood of Laservision ROM having a major impact as a publishing system has, in our view, declined but it is early days to predict the full outcome.

The aim of the Domesday project was to carry out a survey of life in Britain in 1985/86 and make it available in electronic form on two videodiscs. They will publish Domesday on three sides of Laservision ROM discs giving them 162,000 video frames and some 972 Mbytes of data storage. The discs will comprise local and national data - economic indicators, demographic information etc plus photographs, maps and plans all showing aspects and areas of Britain in the 1980's. The two discs, plus the Laservision ROM player plus computer software and the BBC Model B microcomputer will be made available by the BBC and the system will be aimed at all types of libraries, school resource centres, local authority planning departments, trade and industry including marketing companies, journalists and the media in general. The target price for the hardware is said to be £ 2,000.

The facilities and the high storage capacity offered by hybrid disc systems will ensure them a niche in the optical publishing market but we feel it will remain a specialised niche because many of the facilities offered by hybrid disc systems can be offered at significantly lower cost and on a more standardised format by CDI and CD ROM systems.

Compact Discs

Compact discs were designed as a way of publishing and making available high quality audio and because people generally like to listen to music many times and like high quality sound they have proved very successful. Already several million players have been installed and estimates indicate that four or even five million players could be sold in 1986 as the cost of players come down and specialised players for in car use or portable use begin to become available. Compact Discs are not subject to wear or deterioration in sound quality and the players can be very compact and offer users 60 minutes of uninterrupted playing or the ability

to select tracks via a remote keypad controller.

For the publishers of records, at present, they have resulted in a further splitting of the market so that, in addition to gramophone records and audio cassette tapes, they now also have to make their records available on compact discs. While it is likely that in the long term the availability of high quality audio on CDs will expand the size of the record buying public, the short term result has been that it is the disc suppliers rather than the publishers who have gained most from the introduction of CDs and this is reflected in the fact that, at present, publishers are keeping disc prices artificially high. In future, as the overall market expands and replication facilities proliferate we will see CDs sold at considerably reduced prices - eventually lower than gramophone records.

CD ROM (Compact Disc Read Only Memory)

When CD ROM systems were launched in late 1984 and early 1985, most experts agreed that of all the optical disc systems currently on the market, they offered the most potential to publishers - particularly publishers of textual material. The following were the main points seen to be in CD ROM's favour and the reasons for the excitement which greeted its launch.

1/ Just as compact disc systems are all standardised on the format and digital recording techniques designed by Philips and the error correction systems jointly developed by Philips and Sony, so the physical aspects of CD ROM systems are covered by an extended version of the standard specifically designed to meet the requirements of the data processing environment. Hence incompatibility of CD ROM discs at the physical level is not a problem, unlike hybrid disc systems. This basic physical compatibility has allowed publishers, software companies, CD ROM drive suppliers and computer companies to begin to consider and formulate requirements for the next level where standardisation is required - namely at the logical file format level (the order in which the data is recorded on the discs) and the hardware/software interfaces between the CD ROM drives and standard computers such as the IBM PC, XT, AT and compatibles and the Apple and ACT range.

2/ The second advantage that stems from the fact that CD ROM systems are based around CD systems and use the same standards, is that CD ROM discs can be mastered and replicated at CD facilities and most of the components used in CD players are also used in CD ROM drives. Hence, in the short term, the price of CD ROM media and drives will drop as high sales of compact discs and CD players and a build up of disc and player production facilities will force prices down. Currently the Philips CM 100 CD ROM drive and the CM 155 host resident CD ROM controller plus cables, software driver and test package costs £ 1500 in evaluation quantities but when sales begin to take off, many predict that a complete bolt-on CD ROM subsystem will retail for under £ 500.

3/ CD ROM is a digital storage medium with its own EDAC system and hence no elaborate or proprietary coding systems have to be worked out in order to store coded text and other digital data on the discs.

4/ CD ROMs have a storage capacity of 600 Mbytes and hence can be used to store over 200,000 pages of coded text or up to 10,000 raster scanned document images or many hours of audio or combination of the above plus computer graphics.

5/ The physical standardisation of CD ROM systems and their relatively low cost and high

storage capacity has already led many of the world's major computer companies and software companies to herald its arrival as the next step forward in the development of personal computing. Already Digital Equipment Corporation (DEC) have proposed their own file format and offer publishers a complete service from design of their database to replication of the CD ROM discs and their playback on standard CD ROM workstations. Microsoft sponsored a major conference on CD ROM in order to further explore the potential of the technology which it sees as offering hitherto undreamed of possibilities for commercial and domestic users of PC systems and publishers have formed associations in order to investigate just how best to exploit this technology. With all these key players devoting so much time to the investigation of CD ROM, innovative new publishing and information projects are bound to ensue.

Hence CD ROM, with the possible exception of CDI (see below) is certainly the most attractive of the read only optical media for publishing textual databases but are there real applications for this optical publishing system or is it just a problem looking for a solution?

The answer is to be found in the evolution of the personal computer. Since IBM launched their PC and gave the official stamp of approval to the use of PCs in the business community, sales of PCs have grown spectacularly and there can be little doubt that PCs will form the basis of the executive and clerical workstation of the future. Already companies are installing PC networks and dedicated word processing equipment is being replaced by PCs running word processing packages alongside electronic mail, spread sheets etc. In the information world PCs can be linked into the organisation's host to search large corporate databases or they can be connected via telephone lines to external hosts holding large commercial bibliographic and full text databases and there are a number of PC based library automation packages too, offering book ordering, serial control, cataloguing and general library housekeeping packages so the PC revolution is affecting libraries too.

The CD ROM is an add on peripheral for all these PCs (approx 40 million worldwide by 1990 according the recent forecasts) offering a high density, relatively low cost data distribution medium which many predict will form a catalyst for the next generation of office and library automation systems.

In inhouse publishing environments, telephone directories, procedures manuals, health and safety regulations, standards, client lists, product catalogues, general reference works and technical documentation could be distributed on CD ROM and accessed by users at their PC workstations. The advantages would be greater management control, up-to-date information, more interactivity at the search stage and considerable consumable savings in large organisations.

In technical publishing systems, dealers could receive parts lists, product catalogues etc on CD ROM on a monthly basis, with volatile information such as prices and availability data updated online and suppliers of components etc could receive a set of specifications including diagrams etc on CD ROM output from the customer's CAD system. Again, the main advantages of CD ROM would be that the discs are compact and easily handled, there is no need to file microfiche or paper, the CD ROM can be easily and quickly searched via a microcomputer and the user can build up complex search routines which were not previously possible with paper or microfilm systems and download subsets of the database for local processing in the computer.

In inhouse systems the issue of file format standards and standard hardware/software

interfaces between the CD ROM drives and computers is not significant as the company will adopt their own inhouse standard and all staff will be issued with the necessary hardware. In technical publishing too, a large company can set a standard which all his suppliers must follow and, if the savings in consumables are significant, a motor vehicle supplier could offer all his dealers a significant discount if they purchased the recommended hardware to read their parts catalogue on the CD ROM etc.

However, just as with videodiscs, so with CD ROMs, when one moves across to commercial publishing and specifically to general publishing, the issue of standards is important as unless a workable file format standard emerges then publishers who wanted to target the complete market would have to start making a number of different versions of their data available on different CD ROMs formatted to different standards.

Assuming that a minimum standard is reached then the applications for CD ROM in commercial publishing are almost limitless and in a report of this length we can only begin to scratch the surface. We only aim to indicate the areas where CD ROM products look most promising.

One of the first areas to benefit from the introduction of CD ROM systems will be the database publishing industry. An ever increasing number of organisations are building up bibliographic databases covering every conceivable subject area and making them available online to special libraries and end user professionals who access the databases via PCs or other terminals. The databases vary considerably in size and in format - some contain just bibliographic references to articles, papers, books etc on particular subjects while others include abstracts and even, in some cases, the full text of the article. Typically, the publisher of the database makes it available via a host organisation who then advertises the availability of the database, trains end users in searching the database and connects end users to the database via telecommunications facilities and eventually bills them for the amount of time they spend accessing the database or the number of records (hits) they retrieve.

End users range from academic libraries accessing a very wide range of databases to serve the needs of students and academics, to professional practices such as lawyers, civil engineers, doctors etc who will typically make constant use of two or three key databases.

For the user, online database systems, while extremely useful due to their extensive coverage and high degree of topicality, suffer from a number of limitations. Firstly, they can only offer very limited help facilities due to the limitations on the amount of data that can be transmitted down telephone lines in an acceptable timeframe; secondly, they make use of complex search strategies which users have to learn and if one user has to search ten or more databases from different hosts then he has to learn ten different search strategies; thirdly, the user has to pay for each minute he is connected to the database and hence tends to feel under pressure while accessing the database and, in addition to the cost of accessing the data, he also has to pay the telephone charges; fifthly, there can be problems caused by the use of telephone lines such as difficulties in logging on or the danger of getting cut off or getting interference on the line.

For the publisher, online database publishing also has some limitations. The first is that it is very hard to predict yearly revenues as users pay on a usage basis. Also, publishers know that some of the potential market for their product is being missed simply because potential users cannot afford to pay the call up charges and hence publishers would like to find a way to make

the whole or a subset of their databases more widely available to the end user. Finally, they would like to reduce their dependency on a host organisation for putting up and maintaining the databases etc.

Already, therefore, many of the major database providers, including Elsevier, Chemical Abstracts, ERIC etc are showing prototype CD ROM systems holding subsections of their databases and examining the economics of CD ROM for publishing their existing databases.

In addition to making existing databases available locally, however, CD ROM can also be used to package a number of databases or subsets from a range of different databases and hence make available more specialised databases geared to the total needs of specific categories of worker. An example of this packaged approach is the Datext Corporate Information Database. Datext have taken extracts from some six databases including those of Disclosure, Predicasts and Media General, and packaged them on four CD ROMs to provide their users with information on some 10,000 American companies in 900 lines of business. Their software has been designed so that information can be transferred from the databases onto leading PC software packages such as Lotus 1-2-3 to allow users to integrate information from the databases into spreadsheets etc. The Datext database is supplied on a subscription basis and all the user needs is an IBM PC XT, AT or compatible. Datext then provide four CD ROMs, updated monthly, the lease of a CD ROM drive, controller, card and cable, maintenance, software licence and documentation for $ 19,600 p.a. in the USA.

Yet another approach made possible with CD ROM is the simultaneous publishing on one CD ROM of both a bibliographic database and the original full text of the articles. If the articles contain graphics and are not available in machine readable form the page can be facsimile scanned and stored on the CD ROM in facsimile form. This facsimile mode of publishing will enable CD ROM to gradually usurp part of the role played by microform publishing - providing facsimile images of back copies of periodicals and specific book collections etc. However, it must be pointed out that the use of facsimile scanning radically reduces the number of pages that can be stored on one CD ROM to approx 6-10,000 depending on the scanning resolution used and the full page images could only be displayed on a high resolution screen.

Such database products will be readily accepted because they are high value items and publishers will be able to include the cost of the hardware in an annual subscription. Next in line will be expensive specialist scientific encyclopaedias and directories which currently can cost £ 2,000 or more p.a. in hardcopy form and are of vital importance to the scientists that use them. If these were transferred to CD ROM the users would be offered improved searching facilities and the publishers could be saved the expense of hardcopy distribution.

Another area where CD ROM publishing will flourish is in the distribution of raw data for scientific and commercial use. Included here would be statistical information for use in modelling, meteorological and geological data, scientific research data, CAD graphics and government data. Other specialised applications for CD ROM include medical and legal reference publishing, membership directories and marketing statistics.

Software publishing is another area for CD ROM with computer companies using one CD ROM to distribute the latest versions of their operating systems and applications software packages to users of all their models of computers plus full documentation and user manuals and electronic page make-up system suppliers offering libraries of standard graphics, logos,

fonts etc on CD ROM.

The other major potential area for CD ROM publishing was in the home with dual CD audio and CD ROM players being prepared. However, the launch of CDI, which embodies a CD ROM drive plus a microprocessor and a standard for how data, video, audio, graphics and digitised images should be recorded, provides us with a timely reminder that CD ROM is just one type of optical publishing medium and not a general panacea for the publisher. We would now expect CDI to dominate the consumer market.

CDI (Compact Disc Interactive)

As we stated in chapter one, CDI was only announced at the end of February 1986 and specifications have not yet been finalised so we are unable to treat it in detail here. However, it is very clear from what we know to date that CDI is primarily aimed at the domestic publishing market and is well suited to replace pure CD ROM systems in the home, for the following reasons.

1/ For CD ROM drives to be used in the home, suppliers would have to have produced interfaces between the CD ROM drives and a wide range of personal computers, some of them with very little processing power and this would have led to a number of proprietary interfaces with differing performance characteristics and relatively high price tags.

2/ Secondly, for CD ROMs to be used in the home, they would need to carry video and audio as well as data and text information and currently there are no standards for recording video on CD ROM and the CD ROM standards bodies are only addressing the question of data and text storage on CD ROM in the first version of their standard. Hence the first home CD ROMs would, of necessity, have been non standard and discs would not have been interchangeable on different players.

3/ With no hardware/software interface standards and no standard file formats, publishers aiming at the domestic market would have to make numerous versions of each CD ROM disc available and this would result in higher priced discs and hence lower sales.

Hence we can confidently predict that CD ROM will not be widely used in the domestic market for several years, but what of CDI, will that open up a domestic publishing market or is the concept an illusion - a holy grail that Philips are forever searching for but destined never to grasp?

If there is a domestic market then CDI is better equipped to meet it than CD ROM. As we have shown in chapter one, CDI will be a packaged product and, if it is accepted widely like CD audio, then it will provide consumers and publishers with the necessary degree of confidence that if they buy CDI players there will be lots of software available to play on them and if they make CDI discs there will be a large installed base of CDI users to sell them to. When one considers that CD audio discs will be playable on CDI players and that CD audio/CD ROM drives can be upgraded to CDI status by the addition of CDI decoders then one can begin to see that if other electronic companies endorse the standard, CDI could well usher in the age of domestic optical publishing systems.

With the ability to combine data, text, video still frames and sequences and high quality audio, CDI systems would be ideal for distributing encyclopaedias and dictionaries, do-it-yourself

manuals, cartoons, computer software packages, video games etc and in addition to the home market, CDI could also come to dominate the educational market and, potentially the library market where the standardisation and the expected low hardware cost will make CDI very attractive.

Looking upwards topwards the business market there is a grey area at present where CDI ends and CD ROM plus computer systems begin. It will not be clear, until the final CDI specifications are made available, just how attractive CDI will be for distributing and searching complex databases and at what point it will prove more economic for existing computer users to attach a CD ROM drive or use a standalone CDI player.

For libraries our initial feeling is that CD ROM drives will be attached to PCs for professional staff use in searching databases, checking bibliographies and ordering books etc but that CDI players could be on public display for access by users.

One other publishing application that could emerge for CDI's would be computer based audio instruction systems where a passage of audio could be played, the student asked questions and, depending on the answer given, the same or different sequences of audio replayed. Such systems would be less expensive to produce than videodisc systems and require less expensive hardware to use them and in many cases would prove as effective as visual systems. With CDI several levels of sound quality can be specified and for a spoken audio instruction system several hundred hours of instruction could be held on one disc.

OROM (Optical Read Only Memory)

As we indicated in chapter one, OROM is not yet available as a commercial product and when it is the media and the drives are likely to be considerably more expensive than CD ROM. We do not, therefore, see OROM impacting CD ROM in the general publishing environment. Where OROM could have an impact is in the distribution of software and in certain inhouse publishing systems, when it becomes available. The main attractions of OROM to the PC user community would be faster access times and universality of the drives - one drive could be used for read only, write once and erasable media. However, it must be stressed that OROM is unlikely to be commercially available before 1988 and by that time CD ROM will have an unshakeable foothold in the publishing market.

Digital Optical Disks (DODs)

We outlined in chapter one the main characteristics of write once disks and pointed out that their main application will be in the capture, storage and retrieval of large inhouse databases including both coded data and scanned images, rather than as a mass publishing medium for distributing these databases. As such we expect to see write once digital optical disks being widely used inhouse by publishers and information disseminators to build up large databases, subsets of which can then be output onto paper, microform or CD ROM or largescale distribution to end users. Already a number of publishers have embarked on this path, installing prototype optical disk systems to evaluate throughput, scanning reliability, resolution requirements etc.

In the US Information Handling Services, a major technical micropublishing company, have investigated the feasibility of replacing standard microfilming operations with advanced document scanners, optical disk storage subsystems and then raster COM output. One of the

main advantages for a micropublisher would be that the database would be updatable without having to scan the entire collection again.

At present a set of trade catalogues are microfilmed in sequence and copies of the film replicated and sent out to customers with an index. When the collection needs to be updated, old catalogues are discarded, new catalogues are filed in and the whole collection is refilmed. This is a wasteful process as usually 50 per cent of the catalogues are still current and are in effect refilmed.

The alternative, with an optical disk system, would be to scan in all the catalogues and store them on optical disk, with a computerised index and then output images of the catalogues onto microfiche via a raster COM recorder. Then, when it was time to update the collection, the index entries to the outdated catalogues would be erased and just the new catalogues would be scanned in and indexed and then, under computer control, the updated collection would be output in the correct sequence onto microfiche via a raster COM recorder. This would build up a permanent database which could be manipulated and divided up to make a range of publications and would save the effort of refilming catalogues which had not been replaced.

As well as commercial publisher, government agencies and other information providers could make use of just such inhouse on demand publishing systems. The database would be captured on digital optical disk and then, depending on the size of the client, individual reports could be requested and output via laser printers in paper form or on microfiche and whole copies of the database could be distributed on write-once digital optical disk to other government agencies etc. The advantages to the publishers would be the avoidance of recapturing data, savings in warehouse space as they would not have to keep large stocks of paper awaiting orders and increased opportunities to produce specialised publications based around the selective downloading of parts of the database onto paper, microfilm or CD ROM.

As we shall see in chapter three, similar inhouse document and data capture systems based around digital optical disk subsystems could be of immense value in future in national libraries where they could form the basis of efficient interlibrary lending systems.

In this chapter we have looked at some of the potential areas where publishers could make use of optical storage systems to either increase efficiency or increase the value of the information products they produce. We must now go on to look at the impact such systems will have on the recipients of these publications - namely libraries - and on potential inhouse uses for optical storage subsystems in libraries.

Chapter 3

Applications for Optical Disk Systems in the Library and Information Field

Just as the term publishing covers a wide range of activities, so too the terms library and information centres cover a very wide range of organisations from large national libraries with collections of millions of books to small information centres in companies, research associations etc, staffed by one or two people. However, irrespective of size, all libraries and information centres, by their very nature, have to carry out a set of definable tasks and offer a set of definable services and hence we felt that for the purpose of this report the best approach was to try and identify these tasks/services and use this chapter to look at how the optical disk systems described in chapter one could be used to enable libraries to carry out these tasks more efficiently and improve the range of services that they offer.

We identified six tasks/services where we felt optical disk systems would have a role to play in the future and which, excluding the smallest of information centres, we felt would eventually be of relevence to almost all libraries. The six areas are: -

Library Automation - or the use of computer systems to automate library housekeeping activities such as book or serial acquisitions, cataloguing, circulation control etc.

Promotional Activities - the provision of guides to the library or special collections within the library either via staff giving tutorials or via the provision of audio-visual aids.

Reference Services - the potential uses of optical publications in libraries to offer new reference services or as a replacement for existing online, microfilm or printed sources of reference information.

Loan Services - the potential for public and academic libraries to purchase compact audio discs and videodiscs and even, potentially, CDI's containing audio records, video feature films or computer software and video games and then loan them to the public just as gramophone records and cassette tapes are loaned today.

Inhouse Databases - the potential use in special libraries and large national libraries of digital optical disk based document storage and retrieval systems in order to build up and retrieve internal collections of trade literature, special collections donated to the library, newspaper cuttings etc.

Preservation Activities - again limited to major national libraries or libraries with valuable specialist collections who may investigate the potential of digital optical disks for the long term storage of rare and valuable material which is currently stored on magnetic media, paper or microfilm.

Library Automation

One of the first applications for read only optical disk systems in the library market was the distribution of bibliographic databases for reference purposes and, more significantly, as part of work product support systems for current and retrospective cataloguing purposes. Initially, hybrid videodiscs were used to distribute bibliographic databases. Carrollton Press, a member of the International Thomson Organisation, showed a prototype MARC (Machine Readable

Cataloguing) and REMARC (Retrospective MARC) videodisc library system in 1984 called MARVLS. The hardware for the system comprised an IBM PC linked to an industrial videodisc player via a proprietary controller supplied by Laserdata. The software comprised search software and four hybrid videodiscs holding bibliographic records for the 6.5 million unique titles contained in the MARC and REMARC databases. Suggested prices for the system ranged from $ 15,000 to $ 50,000 depending on the number of players and discs required.

More recently the Library Corporation have shown a catalogue production system which they call 'Bibliofile' which is based on a CD ROM subsystem connected to an IBM PC. Here some 1.4 million MARC records are stored on 2 CD ROMs, containing all the Library of Congress's English language cataloguing since 1964 plus popular titles since 1900 and libraries can make use of the system for inexpensive retrospective catalogue conversion, creation of MARC tapes and the printing of headed cards and labels. Already companies supplying IBM PC based library automation packages are planning to incorporate such cataloguing databases into their existing catalogue production systems.

In the UK Sydney Systems offer a microcomputer based library automation system which they call their Micro Library System. It is based around the IBM PC AT & XT and is a modular system aimed at small libraries. The base system allows the user to search in the library database using any element of the bibliographic record; the acquisitions module communicates with the bibliographic database built and maintained by the cataloguing module and passes information to both the enquiry and circulation modules. A serials control module automates the task of managing serial subscriptions and a MARC record interface module allows libraries to obtain MARC data from cataloguing databases and transfer it to the library's inhouse database. To this system Sydney have now added the Bibliofile CD ROM subsystem to provide users of the Micro Library System with instant access to the entire LC MARC database. They can update the CD ROMs monthly or quarterly and they are then available for the library to search at its own convenience. Sydney will provide the CD ROM hardware in the UK, the interface board for the PC and all software and claim that the system can be used for current cataloguing or retrospective conversion and catalogue production. The CD ROM system software allows users to instantly locate LC MARC cataloguing data using a range of fields. The complete system including CD ROM drive, software and the database on CD ROM costs 3682,500. Quarterly updates then cost £ 625 p.a. and monthly updates £ 1,040 p.a. There is also a quarterly update service for foreign MARC priced at £ 360 p.a.

We would expect to see more and more bibliographic data being made available on CD ROM to serve libraries' cataloguing and bibliographic searching requirements. Already the British Library have shown a prototype CD ROM containing 600,000 bibliographic records from their UK MARC file, Whitakers British Books in Print and their Conference Proceedings Index and others will follow. More and more suppliers of library automation systems will offer links to such CD ROM subsystems and, when write once digital optical disk subsystems become readily available, offering low cost, high density storage facilities, then these too will be offered by suppliers of library automation systems so that large, relatively static files such as patron files and circulation transaction records in busy public library networks could be held on digital optical disk.

It is a short step from the provision of bibliographic data and cataloguing subsystems to the provision of optical disc based online book ordering systems where the user is able to search a bibliographic database or a publisher's catalogue and then order selected titles online. Ingram Book Company in the US have shown what they call their Lasersearch Integrated Book

Identification and Acquisitions System. The hardware comprises an IBM PC with 1200 baud modem linked to a Hitachi CD ROM drive. One CD ROM contains records to some 1 million English language books and each one can be searched by author, title, keywords, library code number or Ingram's own code. Once the user has located a title, one keystroke is all that is required to order the book from Ingram via a toll free number in the US. The system will also automatically maintain complete accounting records, keep track of the library's acquisitions budget and print out catalogue cards or hardcopy records for manual filing systems. At present a year's subscription to the software - updated quarterly - is priced at $ 600 in the US.

The next stage forward will be the use of the read only optical discs for full text document delivery with large national libraries such as the British Library and large commercial information suppliers such as University Microfilms (UMI) offering to make subsets of their collections available on CD ROM, either in coded form or in the form of facsimile scanned images. Already UMI have shown such a prototype document delivery workstation and interestingly they also chose to base it around a modified IBM PC which is supplied to libraries by OCLC as a cataloguing, document ordering and serial control workstation. The OCLC workstation is called the M300 and UMI have added their Information Delivery Module (IDM) to it in order to support both local and remote full text database retrieval facilities. IDM has two subsystems, one for receiving, forwarding and printing digitally-transmitted images down a telephone wire from an external source and the other for retrieving, displaying and printing documents and data stored locally on either hybrid videodisc or CD ROM subsystems.

UMI have designed the IDM with the ability to track billing and royalty data in connection with the printing of copyrighted documents and data so users could be charged each time an article is printed from disc. At the stage they do not see the optical disk subsystems replacing existing microfilm publishing systems. They will offer current files of core journals in selected fields on CD ROM. The full IDM workstation will comprise a CD ROM subsystem and a hybrid videodisc subsystem for storing large alphanumeric and images databases locally; database retrieval software for searching the databases stored on optical disc; a facsimile interface to receive documents from a remote information source via telefacsimile and a desktop electronic printer for printing documents retrieved from optical disc or transmitted from a remote source.

To demonstrate the facilities offered by IDM, UMI, in cooperation with the Institute of Electrical and Electronics Engineers (IEEE) contracted with TMS in the US to produce an optical disc database that comprised digital facsimile images of the 1984 issues of 42 IEEE journals combined with an index extracted from the INSPEC database so the user can electronically search the index, retrieve, display and print articles. In addition, the remote information delivery subsystem allows the user to search an online index and order cited articles that are not on the optical disc database over various online systems or networks including the OCLC ILL subsystem. UMI also showed a database comprising its own Dissertation Abstracts International and Comprehensive Dissertation Index to more than 650,000 titles. The database occupied 880 Mbytes and was stored on a single 12 inch hybrid videodisc.

The UMI Information Delivery Module is not yet commercially available and it may well be many years before the facsimile option is economically viable in the UK for all but the most urgent requests but there can be no denying that now optical read only subsystems offer publishers the chance to distribute large databases at relatively low cost for interactive

searching on local workstations and high density recordable digital optical disk subsystems offer publishers and large libraries the ability to create their own data and image databases inhouse, we are moving towards an era when full text and image databases will be made available as widely and as easily as bibliographic databases have been in the past. The implications of this are looked at in more detail in chapter four.

Promotional Activities

In chapter one we described how interactive videodisc systems were being widely used for training and point of sale systems. Already a number of major libraries, including the National Library of Canada (NLC), have created their own videodisc systems which contain a mixture of instructional and promotional material. The NLC's demonstration videodisc is a double sided disc which contains, on side one, a film about the National Library and a series of slides describing the Canadian national bibliography - Canadiana - and on side two, a narrated tour through the library and a history of the Canadian national anthem "O Canada" which is designed to show library users how to set about doing some basic research work.

The videodisc contains twenty seven minute of video on each side and twin audio tracks giving commentary in French and English. To create the disc the library used a production house, an indexer and Pioneer Corp to do the mastering. The disc is not just a simple linear playback disc, the National Library wanted to produce a fully interactive disc system in order to demonstrate the information storage and retrieval capabilities of combined videodisc/ microcomputer systems. The library did their own programming and made use of a Discovision videodisc player linked to an Apple II microcomputer. The total cost of producing and mastering the disc and carrying out the necessary programming was $ 55,000.

While the interactive videodisc system is now a valuable promotional tool, the main reason the NLC created a videodisc systeem was, to quote Sabine Sonneman of NLC, "the National Library felt it would be worthwhile for members of the library community to determine for themselves the status, problem and potential applications of this new technology."(2)

As a result of the project the NLC concluded that a wide variety of library material could be stored on laservision standard videodiscs and made available to the public but that, due to the analogue nature of the medium, it is not well suited to the storage of textual data as a full page of text cannot be resolved on a standard television screen. Hence videodiscs are primarily suited to the storage of audiovisual material such as paintings, photographs, film stills and slides. In addition, since the videodisc cannot be updated and creation of the master videodisc is an expensive venture, videodiscs were best suited to the storage of visual databases that could serve a number of functions. For example, a collection of slides or photographs could be stored on a videodisc and then a number of different software programs written which would retrieve the individual frames in different sequences in order to serve the needs of a number of different potential users.

Certainly we would expect to see, over the next few years, all the major libraries producing promotional videodisc systems designed to inform the public about the treasures that they hold and how best they can be accessed and, in addition, a number of libraries and museums could begin to publish videodiscs containing still frames of various valuable visual collections that they hold. Eventually, as costs come down, interactive videodisc systems could be used as guides to most academic and public libraries and to teach staff and library users how best to use the catalogue; how to access online databases etc.

While never likely to be a major application for optical disc systems in libraries, such

interactive promotional and instructional systems could provide concrete examples of the potential of optical disc systems for library staff and patrons.

Reference Services

In the previous chapter we looked at the potential benefits which a wide range of optical read only media could bring to the publishing industry and we concluded that CD ROM and CD Interactive systems and, to a lesser extent videodisc and hybrid videodisc systems would be used by publishers to market a wide range of commercial information services, reference type publications and home instructional and entertainment products. There can be no denying that these optical publishing media offer the publisher endless opportunities to make his information more easily accessible and hence to enhance the value of his product to the end user. Hence optical publishing is potentially attractive to publishers, offering opportunities for them to open up new markets for their products.

One of the promising markets which has been identified for these optical publishing systems is the library market and in this sections we must look at the type of information products that will be made available on optical read only media and targetted at the library market and analyse just how attractive such optical publications will prove to be to libraries.

By libraries we mean, of course, all libraries including special libraries, research libraries, academic libraries, public libraries and the large national libraries. The first question to ask is whether enough material will be made available on optical media to persuade libraries to invest in the necessary hardware to playback the optical disc and a secondary question is which optical disc system, if any, will dominate in the library market?

The answer will vary widely from library to library but generally speaking the situation with optical publishing will be similar to that which existed in the 1970's and microfilm in the late 1960's early 1970's. Most librarians we have spoken to will be looking for two things from optical publishing. Firstly, valuable material becomes cheaper and/or easier to access on optical disc than on paper, microfilm or online or is only available on optical disc. Secondly, some degree of standardisation emerges both in the hardware, the media and the organisation of the data so that optical discs purchased from a range of publishers/information providers can be read in a range of disc players from different suppliers, attached to a range of microcomputers from different suppliers. When these two preconditions are met then libraries will invest in the necessary optical disc hardware.

For some special libraries with specific subject specialisms that situation could arise very quickly if two or three key information services were to be made available on one optical disc system with a number of attractive value added features that made the databases easier to use. One example here is in the specialised market for demographic information. In June 1985 National Decision Systems announced their Infomark Laser PC system in the US - a standalone workstation comprising a Reference Technology hybrid videodisc drive linked to an IBM PC and a line printer - which gave users the ability to access, analyse and report marketing and demographic information for any location in the US. Some six databases are stored on the 12 inch hybrid disc providing demographic census information, VISION geo-demographic cluster data to identify, quantify and locate any and all consumer household market segments throughout the US; exclusive shopping centre data for over 8,000 major US centres and consumer expenditure data for major retail trade categories. Ten months later, NDS's major competitor in the demographic information business - the Donnelly division of

Dun & Bradstreet, announced a combined optical disk and microcomputer based information delivery system which also makes use of the Reference Technology Datadrive 2000 hybrid videodisc drive, effectively making Reference Technology the de facto standard in that area and allowing information centres to purchase the Reference Technology drive and use it for both databases.

For large academic and public libraries with a number of competing demands on their scarce resources the decision to purchase optical disc systems will be much harder to make and will almost certainly be made on economic grounds - can they access it cheaper on CD ROM than on microfilm or online or will optical media need less staff to manage than microfilm and online systems?

One area where optical publishing systems could gain a foothold quickly in academic and public libraries would be in the backroom as a bibliographic tool. We have already seen above how CD ROM systems are being made available now as part of library automation systems to aid inhouse cataloguing operations. Once the CD ROM drive has been installed, library staff could purchase a range of bibliographic databases on CD ROMs to enable them to carry out bibliographic searches for clients and in addition to the Bibliofile CD ROM described above, the British Library are planning to make their UK MARC file available on CD ROM and Whitakers will make their British Books in Print bibliography available on CD ROM too.

In the US companies owned by Reed International are cooperating to launch a range of CD ROM based bibliographic services aimed at the library market. R.R. Bowker together with International Computaprint are placing Bowker's Books in Print and Ulrich's International Periodicals Directory onto CD ROM discs and their sister company Online Computer System Inc. are developing the necessary workstation which comprises an IBM PC or compatible with 512 K memory, RS 232 communications, a monitor, a CD ROM drive plus controller, printer and retrieval software. The IBM compatible system will be priced at $ 3,000 and the IBM PC version will be priced at $ 4,000. Provided that these early major projects are successful then we will see an ever increasing number of bibliographic databases made available on CD ROM and purchased by all types of reference library.

The same drives could also be used by staff to access other databases, currently available online, if they are made available in full or as subsets on CD ROM for local access. Currently special libraries and academic libraries are heavy users of online database services where they pay a fee to access a commercial database held online on the database provider's mainframe or on a host. These large, up-to-date databases are extremely valuable to librarians but the method of access (via a telephone connection and an intelligent terminal or PC) imposes a number of drawbacks for libraries, many of which were enumerated in chapter two. If libraries were able to purchase subsets of these databases on CD ROM for local rather than distributed access, then a number of potential benefits would accrue.

Firstly, libraries would only have to pay a single fixed price each year, after which they would have unlimited access to the database. This would simplify libraries' budgeting procedures.

Secondly, with the high storage capacity of the CD ROM, librarians and end users could make use of numerous help facilities, menu screens etc which would make the databases easier to search.

Thirdly, without the time constraints imposed by a pay as you use system, librarians could

construct complex search strategies to ensure that all relevant items were retrieved from a database and not just a selection.

Fourthly, many librarians pointed to the fact that with the large storage capacity of a CD ROM, complete backfiles of databases could be stored on one CD ROM or a collection of a number of databases relating to one topic so that libraries serving specific subject areas could look forward to receiving all relevant databases on one or two CD ROMs with a common search software for all of them.

One example of how such databases could be packaged and marketed to libraries is provided by the work of Silver Platter Services - an intermediary company who offer two ranges of services - to publishers wishing to make information available on CD ROM and to libraries who wish to receive that information and make it available to their clients as simply and as cheaply as possible.

The services that Silver Platter offer to information providers/publishers include data capture, if required, specific product design, data preparation, the creation of indices, disc mastering and replication and help with the marketing of the information product, supply of the necessary hardware to libraries and other end users and support and maintenance of both the hardware and the software.

For libraries, Silver Platter can provide the necessary hardware including an IBM PC plus CD ROM drive, controller and the necessary interfaces and software, plus a library of databases on CD ROM, each one of which is readable on the Silver Platter hardware configuration. In addition, they will maintain the hardware and provide an updating service for the software on a monthly or quarterly basis, depending on the terms of the subscription. To date Silver Platter have signed agreements with a number of database providers who have produced prototype versions of their database on CD ROM or have agreed to make all or subsets of their database available commercially on CD ROM. These include PAIS International, a database for the public policy aspects of the social sciences, business, law and economics; ERIC, the Educational Resources Information Centre database, EMBASE from Elsevier Science Publishers, a major source of biomedical information; PsycLIT, a database from the PsycINFO Department of the American Psychological Association; LISA - Library & Information Science Abstracts from the UK's Library Association and, most recently, the NICEM (National Information Centre for Educational Media) database from Access Innovations.

Digital Equipment Corporation (DEC), are the first major computer manufacturer to make a major commitment to CD ROM based systems. They have announced five commercially available databases which are deliverable on CD ROM from leading database providers in chemistry and engineering and are signing up new database providers. They can offer, like Silver Platter, a complete CD ROM application development service for information distributors, designing their databases and placing them on CD ROM; they have announced their own Uni-File standard format for structuring data on CD ROM which has gained the support of a number of major suppliers of CD ROM products, and they have announced the availability of Uni-File compatible CD ROM players which can be linked to their VMS-based VAX and MicroVAX family of computers plus their Rainbow 100 and IBM PC desktop microcomputers.

The five databases currently available from DEC on CD ROM are Chemical Abstracts; Health & Safety in Chemistry; Compendex Aerospace Engineering; Compendex Electrical & Computer

Engineering; NTIS Computers, Communications and Electronics and NTIS Environmental Health & Safety. Each one is priced at between $ 1,150 and $ 1,195 in the US and will be sold on a yearly subscription basis with quarterly updates. Subscriptions include a CD ROM disc with the database and the MicroBASIS search and retrieval software, together with a mini users guide, software documentation and a telephone support helpline.

Many more databases will become available on CD ROM as time goes by and the question must surely be not when but how will the majority of CD ROM databases be marketed to libraries. It is surprising to see major computer companies like DEC acting as hosts in this way but the answer is a simple one at present. As mentioned in previous chapters, the Philips/Sony CD ROM standard only covered the physical characteristics of the media, it did not specify a logical file format for the discs or, in other words, exactly where and how data should be recorded on the discs. The result is that, at present, there are a number of proposed standards, such as DEC's Uni-File and others from TMS, Reference Technology etc but at present they are all proprietary.

Efforts are progressing to devise a common minimal standard which would allow for CD ROM discs to be interchangeable and easily read in a range of drives linked to a range of computers running the main operating systems but at present the only way that a database provider can be sure that libraries can read his database, is to market it via DEC or Silver Platter or other intermediaries and hope that the library opts to purchase or lease their hardware from DEC or Silver Platter. Hence companies such as DEC are trying to sign up as many database providers as possible in an attempt to impose their Uni-File standard as a de facto standard. Clearly for libraries some degree of standardisation is essential as they will not want to have to invest in more than one CD ROM workstation in order to access all the databases that are available on CD ROM. We return to this issue in chapter four.

Looking to the long term, when CD ROM drives are installed in libraries and a wide range of databases are available on them, the next step will be to use CD ROM systems to distribute the full text and graphics contained in the journal articles which are indexed in these databases and already a number of companies that have traditionally made full text information available on microfilm are beginning to investigate the potential of CD ROM as a mean of distributing facsimile images of text, photographs etc.

As described in chapter two, University Microfilm International (UMI) have been investigating the potential of digital videodisc and CD ROM systems for local delivery of full text databases plus facsimile images of journal pages etc and are looking to supply an add-on subsystem to the growing number of PC based library automation systems, which they call their Information Delivery Module (IDM).

With the UMI system libraries could search databases online or locally via CD ROM. Then, once they had retrieved the necessary references they would have two choices. If the articles were kept locally on CD ROM they could search the CD ROM, display and printout the necessary pages. If the articles were not kept locally they would be able to request them online from a national repository such as the British Library Lending Division and have them sent via a facsimile link or, in the case of less urgent requests, via a mail service.

At present there are two limitations to the distribution of facsimile scanned images on CD ROM. Firstly, facsimile images consume 20 - 40 % more storage capacity than the equivalent amount of coded text. As an example, one CD ROM can store approx 200,000 - 240,000 pages

of coded text input from a word processing system. If the same pages of text were printed out and scanned at 200 ppi, the data was compressed at 10:1 and then stored on CD ROM, only approx 6 - 10,000 pages could be held on one CD ROM. However, companies are working on advanced compression systems which they claim could offer compression ratios of 50:1 rather than 10:1 and with 30 - 50,000 scanned pages per CD ROM the economics look more attractive.

The second drawback is that for 200 ppi resolution images to be displayed at full size, the user would need a high resolution terminal and these are extremely expensive at present. Again, however, work is progressing on lower cost high resolution terminals and on the use of zooming facilities which allow portions of high resolution images to be displayed on a lower resolution screen. These are areas which librarians need to keep abreast of and again, we cover them in more detail in chapter four. A number of other micropublishers such as Information Handling Services (Technical Indexes in the UK) are also planning CD ROM based services, lending credibility to the concept.

In summary, therefore, CD ROM will take on an increasingly significant role in reference libraries as a means of accessing bibliographic databases, full text databases and eventually complete back runs of serials and collections of papers which make use of both raster scanned images and coded text.

Compact Disc Interactive systems will also be used in reference libraries to make available dictionaries, directories, encyclopaedia type material and more traditional library stock items such as telephone directories. At this point, we see CD ROM being widely used by library staff for bibliographic searching and for document delivery purposes but it is not easy to envisage CD ROM systems being made widely available to the general public who wish to access material stored on CD ROM. The price of the hardware will prohibit the widespread availability of CD ROM workstations for the public and the use of CD ROM databases will still require some degree of understanding of library and information skills.

The exact impact of CDI is hard to predict as the specifications are not finalised but it would appear to offer a number of significant advantages over CD ROM when it comes to making material available to end users. Firstly, CDI is aimed at the home market and hence users will become familiar with its operation. Secondly, the hardware will be one packaged unit and if consumer sales take off it willl be considerably cheaper to purchase than a combined CD ROM drive plus micorcomputer. Thirdly, as we have shown in chapter one, CDI imposes a single standard for the recording of speech, graphics, data and text on one disc and hence all CDI discs will be playable on all CDI players and librarians will not need to worry over the sort of compatibility issues which CD ROM currently poses. Fourthly, whereas CD ROM will be used to distribute very valuable databases and hence the subscriptions to the discs are likely to cost several thousand pounds per year, the material made available on CDI will be generic material such as encyclopaedias, do-it-yourself manuals, language learning courses, dictionaries etc and should be priced at approximately the same price as videodiscs and videocassette programmes.

Hence we envisage the reference library of the future using CD ROM drives linked in to PC based library automation systems to handle cataloguing, bibliographic searching and document delivery functions while out on open access, alongside microfilm readers and reader-printers, there will be one or a number of CDI players being used to access encyclopaedias, language learning courses etc which users can then, if they require, loan for use on their own players.

Loan Services

Here we look briefly at the potential of libraries holding material on optical discs as part of

their general stock and making it available on loan to their users just as today a number of large public, academic and reference libraries make available material on microfilm, on gramophone records, on audio and video cassettes and on slides. For this scenario to occur two factors must coincide. Firstly, the hardware required to playback the optical discs must become widely available in the home and in schools etc. Secondly, and related to this, considerable amounts of valuable material, of interest to library patrons, must be made available on optical disc.

Looking at the wide range of optical disc systems described in chapter one, we can quickly identify the two or three potential candidates.

The first is obviously compact audio discs. Since the launch of compact disc players, some 150,000 had been purchased in the UK by the end of 1985 and with companies such as Amstrad coming into the market with very cheap systems, it is predicted that the installed base will reach 500,000 in the UK by the end of 1986 and should be close to 2 million by 1990. Similarly, there are now many thousands of titles available on CD Audio and the figure is rising steadily. Hence within 18 months to two years a considerable proportion of library patrons can be expected to possess a CD player.

For libraries already offering record loan services, CDs offer higher quality sound reproduction than gramophone records or cassettes and, more importantly, increased durability. CDs have stood up to considerable mishandling and in libraries all that will be required is a quick visual check to ensure that the right disc has been returned and that it is in one piece.

The next obvious candidate, should they gain the same widespread acceptance as CD audio, would be CD Interactive holding educational material, encyclopaedias, dictionaries, cartoons, video games and self instructional courseware aimed at the home and educational market. The compact nature of both media would recommend them to libraries and the relatively high price tag which both CD audio and CDI discs are likely to command for the next few years will ensure a demand for library services in this area. As described above, libraries can also be expected to install CDI players inhouse to allow patrons to playback reference material and as CD audio and CDI discs can be played on the one player, this will enable them to playback discs periodically to check quality etc.

Videodiscs are unlikely to make library loan shelves as the hardware is still relatively expensive and there are compatibility problems relating to interactive videodisc systems. Similarly, we do not see a market for CD ROM lending services for many years as the discs are likely to contain databases and other expensive material and hence will be outside library budgets.

Inhouse Databases

So far in this chapter we have looked at ways in which libraries will be able to make use of read only optical discs. The majority of the applications related to libraries purchasing material published on CD Audio, CD ROM or CDI - an important area but one where the libraries assume a largely passive role - deciding whether or not to purchase what they are offered on read only optical discs - based on whether there is sufficient valuable material available to justify purchasing the necessary hardware.

The issues here are similar to those which confronted libraries when material began to be published on microfilm or made available online. When backcopies of the Times and other

newspapers and journals were made available on microfilm, libraries had to decide at what point it made sense to invest in the necessary microfilm readers and reader-printers and make a policy decision to purchase material on microfilm rather than in paper form. Similarly, as a number of significant databases began to be made available online, libraries had to decide at which stage to invest in the necessary online terminals and in training up staff to search and access particular databases. So, in the future, libraries will have to decide when it makes sense for them to invest in CD ROM drives or CDI players.

However, libraries and information centres, particularly large academic libraries, national libraries and special libraries serving industry and research associations, are not just passive users of published material and databases, a sizeable number also have to build up their own inhouse databases and collections in order to serve the specialised needs of their users which are not served by any one commercially available service. Hence, in the past, libraries have not only purchased microfilm readers and reader-printers to access microfilm publication, they have also installed their own inhouse microfilm production facilities or hired the services of microfilm bureaux or micropublishers to film their own internal collections or rare books, dissertations, press cuttings, product literature, research reports, clinical records etc.

Indeed, if the collection is sufficiently valuable, libraries will often microfilm it for their own internal use and then make available copies of the film for other libraries to purchase worldwide. In the past a number of major microfilm publishers started life by going to the major UK and European libraries and offering to microfilm their valuable collections for them and provide them with a copy of the film free of charge provided they could have the rights to market the microfilm version of their collections to libraries in the US and worldwide.

Similarly, libraries that access external computer databases holding bibliographic records, abstracts or even the full text of articles in a particular subject area, often use the same technique and the same retrieval software to build up and search their own internal computer databases, indexing articles, reports etc that they hold internally. In fact, many of the top text retrieval software packages currently in use today and likely to be adapted for use in CD ROM publishing, were developed by special libraries to solve specific inhouse database indexing and retrieval problems e.g. Imperial Chemical Industries' (ICI's) ASSASSIN; the Leatherhead Food Research Association's CAIRS and Micro CAIRS and the Atomic Energy Research Establishment (AERE) Harwell's STATUS and Micro STATUS.

In many cases the computer database will index material held inhouse on microfilm and the result is what has come to be known as a computer assisted microfilm retrieval (CAR) system where librarians can access computer databases, find out which articles they have relating to a particular topic, ascertain the microfilm location where copies of those articles are stored and then, using an automatic microfilm retrieval device, retrieve, view and printout copies of those articles and send them off to the student/researcher who made the original request.

In just the same way as read only optical discs look set to challenge online and microfilm publishing systems in the publishing applications outlined above, so recordable digital optical disks are likely to become the dominant storage medium in future for such inhouse computer assisted document storage and retrieval systems because they offer a number of significant advantages over current microfilm or magnetic disk/tape storage subsystems.

Input to an optical disk based filing system can take many forms. Paper documents or images on microfilm are scanned and digitised using the same charge coupled device (CCD) array

scanners that are used today in standard facsimile devices. These break each page/image down into a series of picture elements or pixels. In operation, light is shone onto the page or through the microfilm and reflected or transmitted onto a CCD array which contains, typically, 1728 discrete elements or diodes. Each line is therefore divided up into 1728 segments and the diodes record whether or not each segment contains any information (black text).

To comply with the CCITT Group 3 facsimile standard of 200 pixels per inch, a typical A4 page will be scanned approx 2,000 times horizontally so the page is broken up into 1728 x 2,000 or just under 4 million pixels. In a simple black and white scanning system each pixel is recorded as being black or white and in digital terms this requires one bit per pixel (0 = white, 1 = black) or a total of just under 4 Mbits per page - creating a very high storage requirement. If tonal photographs and other gray scale material has to be scanned then the requirement goes up to at least 3 bits per pixel and if colour material is to be scanned then the requirement is at least 9 bits per pixel. Furthermore in some applications, higher scanning resolutions of 300, 400 or even 600 ppi are required, increasing the storage requirement even further.

However, data compression techniques are available which effectively offer a reduction in storage requirements of at least 10 : 1 currently and some enterprising companies are working on compression ratios as high as 50 : 1. Clearly much research needs to be done in this area for libraries to determine the minimum standards for scanning resolution.

If one takes as a minimum a scanning resolution of 200 ppi and data compression of 10 : 1 then currently some 20,000 A4 pages can be stored on each side of a 12 inch digital optical disk - providing a total storage capacity of 40,000 images per disk.

In addition to raster scanned document and graphic images, coded data can also be stored on digital optical disks in coded form - a significant advantage over microfilm where all information, including data generated on computer systems in coded form, is stored in image form and cannot be reentered into a computer system for processing. Hence in a standard optical disk based document storage and retrieval system documents created on a word processing system can be stored alongside scanned correspondence. Coded data typically requires considerably less storage than scanned image data so a typical 12 inch digital optical disk could store up to 500,000 pages of word processing text in coded form compared to 20,000 A4 pages images.

Once paper and microfilm images have been scanned in and stored on optical disk there are a number of significant advantages to the library and information centre. Firstly, optical disks feature a direct read after write facility like magnetic media so as soon as the document has been scanned and indexed, it can be retrieved and viewed or printed out - there is no delay involved while the disk is filled up or chemically processed, as is the case with microfilm. Secondly, optical disks are random access devices and hence if the disk is mounted on a drive, access time to any one image is under one second. If the library has a large collection of documents then there are three alternatives.

A/ A number of digital optical disk drives can be attached to one system via a network, providing instant access to any document image. The drawback with this option is price as the drives cost in excess of £ 10,000 each at present, including the cost of controllers etc and in a large system ten or more drives could be called for.

B/ An automatic disk handling device called an autoloader device or jukebox can be used.

Autoloaders on the market today can handle from 16 to 200 digital optical disks and load them automatically into from one to six drives, the number depending on the degree of use made of the system. Again, however, such systems are expensive, starting at approx £ 30,000 and going up to several hundred thousand pounds for very large multi-drive systems.

C/ Disks can be stored offline and manually loaded into drives when required as is the case with magnetic tapes today.

The third advantage of optical disk based systems is that multiple users can have simultaneous access to the same store of documents via remote terminals and an image network system. There are a wide range of such systems under development ranging from small scale single terminal personal filing systems linked together via facsimile links to departmental systems with four to six workstations and on up to very large centralised systems with anything from 10 to 100 users linked up to one centralised image database held on one or more automatic disk handling systems or jukeboxes.

There are a number of technical barriers to be overcome before the large centralised systems become widely available at costs which make them attractive to any but the largest and most prosperous companies. These include the provision of sophisticated control software to control the jukebox and ensure that the right images are routed to the right terminals and that requests are prioritised and buffered to make best use of the system and offer key users acceptable response times; the provision of high bandwidth networks capable of handling the demands of a system where up to 50 users could be requesting and receiving images at any one time - this presupposes the commercial availability of fibre optic networks and finally, the availability of high resolution, multi-function workstations at a reasonable cost - currently terminals can cost in excess of £ 10,000 each but terminals are under development which could offer 200 ppi resolution for approx £ 2 - 3,000.

Already a number of companies are offering or developing single terminal or small multi-user departmental systems which could meet the needs of special industrial libraries and information centres, government department libraries and registries and departments in some national libraries. In the UK companies developing such systems include Racal Electronics, International Computers Limited (ICL) and Optronics and worldwide the list of companies developing such products includes Philips with their Megadoc system; Acctex; Canon, Kodak; Filenet; Hitachi; Matsushita; NEC; Ricoh; 3M and Toshiba. Entry level prices for such systems at present range from £ 50 - 80,000 and a four workstation multi-user system with four single disk drives, a large magnetic disk buffer, local processing power, a minicomputer controller, an input scanner and a laser printer for hardcopy would cost approx £ 150-250,000.

Such prices are way above the levels at which they will become interesting to most libraries but it should be remembered that the price of data processing equipment drops rapidly each year and we would expect to see a similarly dramatic drop in the price of such systems over the next three or four years as Japanese hardware suppliers get into mass production and the software suppliers and system integrators begin to develop standard packages that can be adapted for different applications. Many of the hardware elements including scanners and printers, optical disk drives and high resolution terminals will be used in many other high volume applications which will also help to drive the price down and many market analysts expect personal document filing systems to be available at the £ 10 - 15,000 level by the early 1990's.

At the low end, one major factor which could affect the price of these systems will be the

arrival of the universal optical disk drive. A large number of major computer companies and drive manufacturers are working on universal 5.25 inch optical disk drives which will be capable of accepting both Optical Read Only Memory (OROM) disks plus write once optical disks for recording document images and data and, eventually, erasable digital optical disks. If such drives were to be supplied with a new generation of PCs, as seems very likely, then all users would need to attach to their system would be a terminal upgrade card and a document scanner and port through to a shared printing facility and personal document filing systems could become a reality with the same retrieval software used to search both external and internal databases.

It must be stressed here, however, that whereas with read only optical discs we are talking about products which are here today or likely to be available within one year, with digital optical disk based filing systems we are looking at systems which are unlikely to be used widely in libraries for another two years or more. Coming back to what is available now, we must close this section with a brief comment on the optical disk systems installed at the Library of Congress and the German publishers Gruner & Jahr.

In 1982 the Library of Congress contracted with Integration Automation, a leading US systems integrator in this field, to develop the Library of Congress Optical Digital Disk Pilot Project. The objectives of the programme were to develop and implement an optical digital storage and retrieval system for library print materials and to evaluate the use of this high density electronic technology for information preservation and management. The LC has designed and is implementing the use of a modular system which allows for component changes and enhancements as the technology advances. The system will provide online access to records and display of associated image data on user terminals. The System software comprises two packages designed by the Library's Automated Systems Office - ISOO (Input subsystem for the optical disk) which controls all input scanning and quality review functions, disk availability directories and image transfer to the optical disk and ODIS (Optical disk interface system) the interface between the optical digital data disk system and the LC IBM mainframe which allows users to search, identify and select documents.

System hardware comprises the following. For input IA developed a multi-purpose scanner capable of scanning documents up to 11 x 17 inches which has a manual and an automatic feed and will be used primarily for paper documents and books. Throughput is 2 seconds per page. Also available is a microfiche scanner designed to scan standard 24X reduction 98 frame microfiche. This was essential as one of the aims of the LC and the Congressional Research Service was to use the system to replace a computer assisted microfiche retrieval system run by CRS to provide the congressmen with a news clipping service.

Other hardware includes a Compander for data compression and expansion; 4 Winchester disk drives which are used as an intermediate storage media for buffering compressed images from the scanners for quality review and for retrieval and use at user terminals; the Alcatel Thomson Gigadisc (ATG) digital optical disk drives - self contained read/write units capable of storing 1 Gbyte of data per side; the Video System Controller - a high speed switching device and controller supporting 32 ports; an optical disk autoloader or jukebox capable of holding up to 100 disks and loading any one automatically into the ATG drive; a terminal cluster controller which supports communications and buffering for all workstations and user stations; 2 workstations - image display terminals for input scanning and quality review functions; 6 user stations - public image display terminals located throughout the Library which allow users to search the computer index and retrieve and display full text images of the scanned documents;

two convenience printers - Xerox 2700 laser printers and one remote printer - a Xerox 5700 high speed laser printer.

Already valuable experience has been gained concerning data and image integration, laser printer operations, user friendliness of an image retrieval system, quality control operations, document preparation procedures and recording operations. In July 1984 the LC began writing to a prototype ATG digital optical disk drive which was installed and maintained by Integrated Automation. Today the LC is scanning in 4 - 800 pages per day. Significant effort was required initially to debug and integrate the systems hardware and software. Merging the index file which operated under the LC Information System (LOCIS) with the document (image) file took considerable staff resources but now they have progressed to testing the communication of images to remote retrieval locations via networks. The LC decided to scan documents at 300 x 300 pixels per inch and they have been carrying out image enhancement and scanning halftones and grayscales for greater clarity with graphic materials. They are using 300 x 150 ppi displays for viewing the images and printing out at the original 300 x 300 ppi on the convenience and remote laser printer.

A number of documents from the bibliographic citation file have been entered into the system and plans are underway to begin scanning entire periodicals to build a larger file for user testing. To complete user acceptance testing until the end of 1986, the Library has ordered an additional high speed scanner, production level optical disk drives, additional optical disk media and a new jukebox which has now been installed. Clearly this is a long term project and one which needs to be followed closely by other national libraries in order to ascertain those areas where further research work needs to be done.

The German publishers Gruner & Jahr installed a prototype version of Philips' Megadoc digital optical disk based document filing system and have since migrated to the full production version of Megadoc which comprises an A3 document scanner; a Philips P 4000 minicomputer with magnetic disk storage; the OSI Laserdrive 1200 12 inch digital optical disk drive; the Filenet sourced jukebox capable of storing 64 double sided disks and serving up to 4 Laserdrive 1200 drives; a choice of 100 x 100 or 100 x 200 ppi resolution terminals and Philips' own hardcopy printer.

The application involved replacing a computer assisted microfiche retrieval system for their newspaper cutting library. The press documentation system was set up by Gruner & Jahr in the early 1970's to meet the needs of their journalists and researchers for fast retrieval of both text and pictures. The two main requirements were for a computerised index to the files and the storage of the documents in compact facsimile form. They decided to use computer assisted microfiche retrieval system and now have over 1 million documents indexed on the computer and 1.6 million pages stored on microfiche. They also have a further 5 million pages in paper form and all the 1.6 million pages which have been filmed have also been retained in paper form. Over the years Gruner & Jahr discovered that for their application, microfilm suffered from a number of major weaknesses including the fact that it is almost impossible to enhance the image so poor originals lead to poor microfilms; there are very few microfiche systems offering direct read after write facilities; the automated retrieval units required to store 1.6 million pages are very bulky and prone to breakdown and it is almost impossible to provide simultaneous multi-user access so when there is a run on a particular set of files delays result.

From 1978 onwards they therefore looked for an alternative to both the existing microfiche system and also the large paper archive that would allow them to continue holding the index

on their mainframe and would allow them to transmit images and display them on remote user terminals. The other main requirement was that the system should provide a more compact storage system and reduce staff costs over the long term. They opted for a Megadoc electronic document storage system and planned to introduce it on a pilot basis in four stages. Firstly they installed a narrow pilot installation to test the technical interaction of the main components and put them into operation. Then they installed a complete input and output subsystem with several workstations to test over a 9 months period the efficiency of the system in a production environment. Thirdly, additional input equipment was purchased so a substantial volume of material could be input to the system from the old paper stocks. To date they have scanned in and stored on digital optical disk in excess of one million pages. Finally, the retrieval system has been enhanced by the installation of the Filenet jukebox and more retrieval workstations to meet the full requirements of Gruner & Jahr's system. The Gruner & Jahr system must represent the largest store of images currently held on digital optical disk and now that the bulk of the conversion work has been completed we await with interest to hear figures relating to the usage of the system including response times, mean time between failures etc.

These two pilot applications are of particular interest to the library community but there are many more systems being installed on a pilot or full commercial usage basis in the US, Japan and Europe and by the end of 1986 we would expect a wealth of valuable user feedback to be coming from these early installations, which will be of considerable value to the next generation of users in planning the implementation of these systems. We deal with some of the issues posed by these systems in the library environment in chapter four.

One point that we would stress here, as in the chapter on publishing applications of digital optical disk based document storage systems, is that once a national library or a library with a valuable special collection has made the investment needed to convert it onto digital optical disks, the library can then repackage that database in a number of different ways and make it available to a number of different libraries on a number of different media. Images stored on digital optical disk can be output onto paper via laser printers, onto microfiche via raster Computer Output Microfiche recorders or onto CD ROM and other read only optical discs by spooling the data off onto tapes and preparing master tapes from them. Hence inhouse digital optical disk systems could enable libraries to disseminate information more effectively in the future and the value of that information and the revenue obtainable from publishing subsets of it could help justify the initial investment in setting up that database.

Preservation Activities

Currently all the world's major libraries, smaller libraries with specialist collections, archives, museums and any organisation which is tasked with holding valuable material on paper for long periods of time, are facing major preservation problems. For convenience we will divide these up into two categories:

1/ The first preservation problem relates to the preservation of existing holdings of paper documents - rare books; journals; reports, photographs and other ephemera. Quite simply, the National Libraries are in a position where their vast holdings of books, journals etc are deteriorating at such a rate that every year thousands of books become unusable. Currently there are two solutions - to repair and treat the book or journal itself by applying deacidification techniques etc or to microfilm the book before it becomes illegible and while the pages can still be turned.

Given the fact that the Library of Congress has 80 million books and other material in its

collections, even a simple process like microfilming represents a considerable expense and no national library can devote sufficient resources to a preservation microfilming project to begin to solve the problem. Both the Library of Congress and the British Library spend millions of pounds each year on microfilming books, newspapers and journals in order to preserve them, to save space and to make the material more easily accessible to scholars but each year more books and journals are acquired by these libraries than are filmed so the backlog of material to be filmed simply gets bigger and material continues to deteriorate and is effectively lost to the world of research and scholarship simply because the resources are not available to help preserve it.

Against this background what can recordable digital optical disk systems contribute? One of the aims of the Library of Congress system was to evaluate the potential of a digital optical disk system for the long term preservation of document images and to consider optical disks as an alternative to microfilm for the capture, storage and retrieval of document images. A number of commentators have claimed that such systems will have a major role to play in the preservation of documents in the future and predict that recordable digital optical disk systems will replace microfilm as the chief archival medium for document image storage. This claim should be treated with considerable caution, however, for a number of reasons:

Firstly, one of the main problems facing libraries at present is a lack of resources. There simply is not sufficient money available to microfilm all the documents that need to be preserved. At the present time digital optical disk based document storage systems are between 10 and 20X more expensive to set up and implement than microfilm systems so if the libraries cannot afford largescale microfilming systems they certainly will not be able to afford digital optical disk based systems at present. However, a spokesman from Kodak recently stated that their research indicates that by the end of the decade or the very early 1990's it could become cheaper to file images on optical disks than on microfilm, owing to the fact that very high density disks will be available by then and systems will be selling in volume so hardware and software costs will reduce.

Secondly, as described briefly in chapter one, there is the problem of standards. The optical disk business is still evolving and companies are entering and dropping out of the market. At present there are no standards relating to 12 inch digital optical disks and there is very little second sourcing of disks or drives. This means that users of digital optical disk systems are embarking on a path which will inevitably involve them in copying disks at regular intervals; upgrading drives at regular intervals and periodically renewing the entire system as suppliers withdraw support from outdated systems etc. This is standard practice in the computer industry and can be planned for and budgeted for but it is nevertheless a considerable overhead and one which libraries do not currently face with microfilm systems. The question for the archival life of the media is related to this. Currently disks are guaranteed to last 10 years and given the technical obsolescence factor this is likely to be all that users can hope for. This question is discussed in more detail in a Cimtech report (3).

The first generation of digital optical disk based document storage systems are primarily targetted at organisations with active file folder systems - insurance companies, building societies, banks etc - where their high cost can be set against considerable staff savings, the ability to provide a better service to customers etc. In these applications the systems are not designed to simply capture, store and retrieve document images, they allow users to scan and annotate images, merge images and data on one screen and generally work with document images as part of their daily routine and they are sold as document processing systems rather

than simply as alternatives to microfilm for the low cost storage of documents.

The Library of Congress application and the Gruner & Jahr system are both of this type and relate to very specialised, very actively used collections of documents - the Congressional News Service and a newspaper cutting library - not to a general purpose archive.

Hence we see the use of digital optical disk filing systems being confined, for the next three or four years at least, to small active specialist collections where the investment required in terms of hardware and staff resources in capturing and indexing the documents, can be justified because of the heavy usage that will be made of the collection.

In archives and large libraries only some 5 - 10 % of the stock is ever used and the main requirement is simply to preserve it and keep it in a legible condition so scholars can access it when they need to. There is no requirement here to provide split second retrieval times or online computer indexes, a roll of microfilm with a rudimentary index on the box is adequate and is all that they can realistically expect to afford for many years to come.

2/ So far we have only looked at how to preserve existing paper documents. This is a pressing problem but it is only part of the overall preservation problem. The second area which we must now address is the question how to preserve the increasing amount of information that is generated electronically via word processing and data processing systems and is hence available in machine readable ASCII coded form.

Ever since the world's major libraries were set up, their function has been to acquire, store, classify and make available information stored in books, journals, newspapers and other paper documents. In the UK, to aid the libraries in this task, copyright legislation has designated five major libraries in the UK, including the British Library, copyright deposit libraries, and publishers of books, journals etc are required by law to provide free copies of every new edition or new journal title to the relevant copyright libraries, in return for which the books etc are classified and entered into the national bibliographies. The main problem for these large national libraries to date, as we have shown above, has been to preserve the many millions of books and journals which they now have in their possession and to minimise the space needed to store them and this they have done with the aid of vast microfilming programmes and book conservation programmes.

Today, however the printed word is not the only way of disseminating information. Increasing amounts of data are produced and created on computer systems and made available electronically via networks or telephone lines. The prime example of this, as described in chapter two, are the increasing number of database publishers, who create large bibliographic and full text databases on mainframe computer systems, store them on magnetic disks and charge libraries and other professional users for accessing and searching them online via an intelligent terminal or microcomputer connected to their mainframe via a modem and a telephone line. There are many hundreds of such databases available now, relating to almost every scientific, technical and academic subject. In addition, several scholarly journals are now being published electronically and a wide range of information providers make material available via Prestel and other private viewdata systems. While some of the online databases are also made available in printed form, an increasing amount of valuable information is never printed out today and hence is not subject to the law of deposit and is not made available to the copyright libraries. Furthermore, even if the law was to be extended to cover electronically published information, many of the databases are updated in real time so it would be difficult

to define an edition.

In 1983 the Office of Arts and Libraries set up a working group to look into the issues raised by electronic publishing and they published a discussion document entitled 'The Impact of Electronic Publishing' (4). Two areas of importance for deposit libraries emerged - how to identify and secure definitive versions of UK publications and how to provide for the continued availability of obsolescent material. Following this Susan Hills of the Science Reference Library produced an excellent report entitled 'Electronically Published Material and the Archival Library' (5) in which she summarised the problems that will face any archival library attempting to collect, store, catalogue and make available fully electronically published material.

She grouped the issues under five headings - archival; technical; cost; legislative and policy - the main ones where what kind of data should be kept; what is an edition; should any data be discarded; which storage media should be used; how is the material to be translated to this media; what standards should be used; how long can it be kept without deterioration; how can access be made to particular items; what will each stage cost; are royalties envisaged and will deposit of electronic publications be included in a new act?

We are not qualified, nor is there space here, to deal with all the policy and legal issues but we will attempt in the rest of this section, to show how optical disk systems could be used in future electronic archives and their main strengths and weaknesses.

One obvious area where read only optical discs as CD ROMs could help to solve the archiving problem, would be if, as seems inevitable now, the database providers go ahead and make all or subsets of their databases available on CD ROM as well as online. The benefits which the optical publishing of databases could provide to publishers and end users are described elsewhere. The main benefits for copyright deposit libraries would be that databases on CD ROM can be handled like other publications and it would only require a small amendment to the existing deposit legislation to include such optical publications.

CD ROMs would have two other significant advantages for archive libraries:

Firstly, while no definitive ageing tests have been carried out to determine the lifetime of CD ROMs, it appears likely that they, like compact audio discs and videodiscs and other read only optical disc systems, will prove to be a very durable medium and they should certainly last in excess of 10 years - far longer than any magnetic medium currently being used to store databases.

Secondly, CD ROMs are a standardised medium and, provided the efforts of NISO and others are successful and a standard logical file format is established for CD ROMs, then data on any CD ROM will be readable on any CD ROM drive connected to any computer running a standard operating system.

Realistically, of course, many databases will never be published in their entirety on CD ROM but they may come to be stored on another kind of optical disk storage system which looks well equipped to play a major role in future electronic archives - namely write once digital optical disk (DOD) systems. Database providers themselves have already expressed considerable interest in the potential of recordable DOD systems and if they were to use these rather than magnetic tapes to backup their databases then again, it may be possible for

libraries to come to some arrangement with the database providers whereby, after a certain period of time, backfiles of the database could be deposited on a recordable DOD.

As outlined in chapter one, write once DODs will not challenge magnetic disks as the prime computer storage medium for two main reasons:

Firstly, although write once digital optical disks (DODs) have very large storage capacities, the access time and data transfer rates offered on the first generation systems is relatively slow and cannot compete with the access speeds and data rates offered by standard magnetic disk subsystems.

Secondly, as their name implies, write once disks are non erasable and hence they cannot easily be interfaced to current computer systems because the operating systems used on these systems are all programmed to deal with erasable storage media where they can read off and rewrite files hundreds and thousands of times.

Hence, despite the fact that write once optical disks offer high storage capacity, removability and excellent durability, they will not challenge magnetic disks in the majority of applications. Only when erasable optical disks become available at the end of the decade will magnetic disks be under threat.

However, write once optical disks are ideally suited as a back-up storage medium and are expected to challenge magnetic tape archiving systems for the following reasons:

Firstly, the first generation of 12 inch write once digital optical disks have a storage capacity of 1 Gbyte per side which is 20 - 30X greater than most magnetic tape systems and already companies such as Kodak are showing systems capable of storing 4 - 5 Gbytes per side.

Secondly, DOD's are removable like magnetic tape systems so there is no limit to the amount of data that can be archived and read back via one DOD drive with DODs stacked offline and loaded manually. In addition, DODs, unlike magnetic tapes, can be easily handled automatically by robotic arms and already a number of companies have shown jukeboxes which operate under computer control and can load any one of up to 200 disks into one of a number of drives.

Thirdly, because data is written onto and read off digital optical disks using a laser beam focused from a distance onto the surface of the disk, there is no danger of head crashes or any other mechanical head damage of the type that magnetic tapes can suffer from.

Fourthly, magnetic tapes need to be refreshed every 12 months and recopied every 2 - 3 years to remain readable but digital optical disks will have a lifetime of at least 10 years without any maintenance requirements.

Finally, digital optical disks provide random access so any data on a disk can be retrieved in approx 1 second - far faster than with serially accessed magnetic tapes.

In addition to the database providers, the UK's Central Computing and Telecommunications Agency (CCTA), a division of the Treasury which advises all government departments on the use of computer systems and all information technology, were very quick to appreciate the value of write once digital optical disks as a data archiving medium. Their Future Systems

Division set up a pilot tape to DOD archiving subsystem comprising a DEC VAX minicomputer from Systime with a tape drive, an operator console, line printer and links to a ruggedised digital optical disk drive supplied to Hollandse Signaalapparaten BV, a subsidiary of Philips. They took tapes from the Property Services Agency (PSA) at Hastings, and copied them onto the DOD and back onto tape a set number of times in order to check for errors and to see how much data could be stored on the DOD. They used the DOR Input/Output software package developed by Signaal.

The results of the trials were encouraging and CCTA set up an optical disk working group comprising representatives from all the main government departments with large tape archives in order to disseminate their findings and help the departments to formulate their requirements for DOD based archiving systems and implement such systems. The tapes supplied by PSA were 2400 ft 1600 bpi tapes and CCTA expected to be able to record the contents of 30 tapes on one side of the DOD. In reality, since none of the tapes were full because government policy is not to use the first or last 200 ft of the tapes and never to split files, CCTA were able to store the contents of 63 tapes on one side of the disk and to demonstrate the potential for considerable consumable savings.

PSA have some 6,300 tapes in their archive and calculate that it costs them £ 100,000 per annum to maintain, refresh and copy them. With DODs all they would need would be 100 disks stored in racks or in a jukebox unit and they are looking to install a standalone tape to DOD archiving system. Of more interest to the library world, the Public Record Office (PRO) have recently issued an operational requirement for an optical disk based archival system to be installed at the PRO in Kew for the long term storage and retrieval of digitally encoded data. Records held on the computerised systems in operation in government departments are subject to the Public Records Acts and the PRO has been aware of the need to preserve digitally encoded records since the early 1970's and have earmarked certain records for eventual transfer to the PRO and permanent preservation there.

Currently they estimate that some 2,000 tapes are awaiting transfer with a further requirement to transfer 200 tapes per year thereafter. To date the high cost of maintaining such an ever increasing tape library has proved prohibitive but the PRO now consider that digital optical disks offer a viable and more cost effective alternative to tape systems and hence, under the guidance of CCTA, they are installing a pilot optical disk system - an offline magnetic tape to DOD backlog conversion system which will enable PRO to evaluate the viability and cost effectiveness of taking magnetic tapes from a number of sources and archiving them to optical disk in a common format. Librarians and archivists everywhere would abviously be well advised to monitor very closely the progress made in this significant project.

One example of the type of subsystem that will be required to archive from tape to digital optical disks, is provided by the OAS system (Optical Archiving System) developed by Aquidneck Data Systems in the US. Aquidneck Data Systems are a systems engineering and software development firm in the US who carry out the bulk of their work for the US Department of Defence. Their optical disk archiving unit was a by-product of a request from the US navy which was having problems transporting magnetic disk packages from a development site to its Cruise missile sites without damaging the disks. Optical disks seemed like the perfect solution because they could not really be damaged and the result, after several million dollars worth of research and development, was their OAS, which sells for under $40.000 in the US.

OAS is an optical disk based storage and retrieval system which can be easily attached to

virtually any host computer configured with a tape drive. The user merely unplugs the cables from the existing tape drive and connects them to the OAS and optionally then the user can also plug the tape drive back into the OAS. The OAS is intended to support the tape backup and archiving facilities on most computer systems, saving space and operator time when compared with tape reel storage and handling.

Aquidneck designed OAS to meet two specific objectives: to provide the user with an easy way to begin using optical storage in current backup/archiving operations, without requiring host computer software development or changes to operating systems or application programs and to provide the user with a means to convert magnetic tape libraries to optical disk libraries with minimal impact on daily operations in a manner which is compatible with the current optical disk archiving system. OAS can provide both capabilities in a choice of three operator-selectable modes:

In online mode the OAS appears to the host computer as a 9 track, 1600 bpi, PE tape formatter and deck. When data archiving takes place, the data is written by the OAS controller to optical disk instead of tape. The OAS interface to any Pertec type tape controller over the two standard I/O cables and accepts all of the standard tape I/O commands. OAS uses a 12 inch DOD. The OAS is controlled by the host computer through the existing host tape facility/backup software so no software modifications are required.

In passthrough mode the OAS allows the host computer to access a user-attached magnetic tape drive in the same manner as prior to the introduction of the OAS thus providing for continuity of existing tape read and write operation.

In offline mode the OAS provides the user with the capability to control an attached 9 track magnetic tape unit and optical disk drives for tape to DOD or DOD to tape data transfers without requiring host computer intervention. The operator need only mount a magnetic tape, insert an optical disk and initiate the copying action from an attached terminal. The OAS software allows the operator to copy an entire tape, records between filemarks or individual records; to display the optical disk directory; to compare tape and disk data for copy verification and to restore a tape that has been copied to optical disk. In future, OAS will offer data encryption; data compression to provide an extra 30 to 60 % disk capacity and the ability to link one controller to up to 8 drives in order to increase online storage for large volume applications.

Hence it appears what write once digital optical disks will provide a technically feasible and cost effective alternative to magnetic tape for the long term archiving of digital data and could prove very attractive to a number of archives and national libraries who wish to set up electronic archives. However, the question of standards still remains to be resolved together with the other issues raised by Susan Hills in her report.

We consider that for the forseeable future it may be necessary to distinguish between that data which must be reprocessed in the future or which needs to be displayed in three dimensional form (in the case of CAD generated drawings) or searched via full text retrieval software (in the case of full text databases) etc and hence which needs to be kept in machine readable form and that portion of the data generated on computer systems which, after a certain period can simply be printed out in image form and accessed by scholars if and when required. For the first category of material write once digital optical disks will be ideal, provided the standards question can be resolved. For the second category then computer output microfilm could be

the ideal medium - making the material compatible with source document microfilm and readable via low cost optical systems.

Before leaving this chapter on library applications of optical disk systems we need to address very briefly one final area where recordable digital optical disk subsystems are destined to play a major role and that is in the provision of document delivery systems. In the UK a consortium of publishers which goes under the name of ADONIS, together with the British Library Lending Division (BLLD), have been cooperating in an ambitious project designed to test the viability of document delivery systems based around the use of digital optical disks and a similar project called Transdoc has been conducted in France with the support of the European Commission.

The ADONIS system has undergone several evolutions but the original concept was that instead of holding its journals in paper form or on microfilm, the BLLD at Boston Spa should scan the contents of the most heavily used journals and store them in facsimile form on digital optical disk. They could then distribute copies of these disks to major document supply centres throughout Europe and they would use them to satisfy requests from libraries for copies of the articles contained in those journals. When a request was received either online or by telex or by telephone, the BLLD would retrieve the relevant article from the disk under computer control and then print out the article on a laser printer and send it to the requesting library. In future, as wideband communication networks became available, the aim would be to automatically send a facsimile image of the article through to the requesting library, providing fast delivery of the full text or journal articles. The Transdoc system aimed to provide a similar service by scanning. Commission documents and storing them on digital optical disks so member countries could then access an online index to the Commission documents, make a request for certain documents and receive facsimile copies.

The problem with these schemes was firstly, as we pointed out in the previous section on inhouse databases, the high cost of current digital optical disk systems and the problems involved in scanning in high volumes of documents and secondly, the lack of suitable telecommunications facilities at a price which most libraries can afford. The potential benefits, as described in the section on publishers' inhouse databases, would be, for the publishers, the fact that they could monitor the usage made of certain publications by libraries and collect royalties and, for the libraries, simpler acquisition procedures, faster service to users, staff savings and the ability to carry out Selective Dissemination of Information (SDI) services for users - providing them with copies of the full text of relevant articles and not just a list of references etc.

Looking to the long term, it might prove more productive for the national libraries and the publishers to try and cooperate and investigating ways of making the full text of their journals available in machine readable form with just the graphics in facsimile form as this would considerably reduce the amount of disks needed to store the journal articles and the hardware needed to capture and playback the data and hence allow the scheme to cover a significant proportion of the titles held by the BLLD. It would also overcome the communication problems.

Clearly, in covering so much ground and pointing to all the areas where optical disc systems could and will be used in the library and information field in future, we have done no more than scratch the surface and we have raised a lot of issues which will need further investigation by the library community. In the final schapter we will attempt to list all the

issues and point out where research is currently being done and where further research could profitably be undertaken.

Chapter 4

Issues relating to the use of optical disc systems where research could and is being profitably carried out by the publishing and library and information world

Standards

One of the key issues relating to the use of all read only and write once optical disk systems at present and to the use of erasable digital optical disk systems in future, is that of standardisation. There is an urgent need for publishers and librarians to be aware of what standards are available now, what level of standardisation will be needed before certain media can be used as generic publishing media, what level of standardisation can realistically be expected to emerge from the work currently being conducted in the US, Europe and Japan, when the standards position is likely to be clarified and what effect the lack of any meaningful standards would have on the potential use of optical discs in libraries?

The issues raised are extremely complex so all we can attempt to do here is give a simplified account of the present position and list the organisations who are working in this area so that readers interested in pursuing this topic in more detail can contact them.

With videodiscs, as we said in chapter one, Laservision is the de facto standard for laser optical videodiscs and all standard serial play Laservision discs can be played back on Laservision standard players, whether produced by Philips, Hitachi, Pioneer, Sony, etc. However, when one starts to design more sophisticated computer controlled interactive videodisc systems such as the one developed by the National Library of Canada, then the producer has to specify which player and which computer/operating system the system has been designed around.

With hybrid videodiscs there are no standards at all - data is encoded onto the discs in different ways by different companies and the publisher has to select one company's system, use it to record the data on the disc and make of that company's proprietary player or analogue to digital conversion system to read back that data at a later stage.

With CD audio the physical specifications for the media and the technique for recording and playing back audio information are all laid down in the Philips/Sony Red Book so all compact audio discs produced to that standard can be played on all standard CD audio players.

With CD Interactive again the media and the technique for recording and playing back audio, video, text and pure data will be laid down in the Philips/Sony Green Book and provided CDI's are produced to that standard they will be playable on standard CDI players.

With CD ROM the physical specification for the medium and the technique used to record and read back data from a CD ROM is laid down in the Philips/Sony Yellow Book but the logical file format or the way in which the data on the disk is organised and indexed is not specified. Until this file format can be agreed, there is no compatibility between different CD ROM discs and there is a danger that CD ROMs could become like floppy diskettes - only readable on one make of computer running one operating system.

To avoid this situation and increase its value as a publishing medium, a group in the US called the High Sierra Group comprising leading computer suppliers, software companies and

publishers are cooperating to produce a working file format standard and the US National Information Standards Organisation (NISO) have formed a committee to consider all the proposals and, in due course, agree a standard. It is expected that a first level CD ROM file format standard covering the recording of text and graphics on CD ROM and compatible with that part of the CDI standard which covers text and data, will be made available by the High Sierra Group by the end of May 1986 and will eventually be ratified by NISO.

Turning to write once digital optical disks, there are currently no standards relating to first generation 12 inch disks and significant progress looks unlikely due to the fact that manufacturers are already geared up to produce their own proprietary systems now. With second generation 5.25 inch disks, however, there is more scope for agreeing standards before production begins. The first meeting of the International Standards Organisation's ISO TC 97/SC 23 (Optical Digital Data Disk) subcommittee took place in Tokyo in May 1985 and reviewed their programme of work which included the development of standards for optical media units having diameters of 356 mm; 300 mm (12 inches); 200 mm and 130 mm (5.25 inches) respectively. The Japanese Standards Association have already produced a working document for 300 mm optical media units and at the Tokyo meeting two documents were produced to help in the production of a draft proposal for 130 mm media. These were a proposed general structure and a record of current consensus on the values for all the parameters. An editing group was set up to produce a first draft proposal re 130 mm optical media and the next meeting of ISO TC 97/SC 23 in Geneva in September 1986 will consider the work of the editing group.

In Europe, Learned Information have recently set up a body called the Optical Disk Forum comprising European publishers, database providers, retrieval software suppliers, hardware suppliers and technical consultants whose role is to monitor developments in the optical disk standardisation area and report back to their members. Recently they completed a questionnaire sent out by the High Sierra Group to give their input to the CD ROM file format standardisation process and they are currently investigating the implication of CDI systems. With the funding of the Commission of the European Communities (CEC) DGXIII, they are also carrying out a major study of the standards work being conducted in the US and the implications for the European publishing industry and the findings of this report are due to be presented at a conference at the Commission building in Luxembourg on May 16th 1986 when members of the High Sierra Group will be present.

Hence one must conclude that there is a considerable amount of work being done in the standardisation field and a general recognition among the hardware and software suppliers and among the information world as a whole that there is a need for standardisation and for interchangeability of the different disc systems if optical discs are going to achieve their full potential as an information storage and dissemination medium. There are many significant hurdles to be overcome and the process will take years and there is therefore a need for the publishing world and the library world in Europe to follow the lead given by the American Library Association and the Information Industry Association in the US and set up technical committees to monitor progress in the standards area, to educate their members in the issues involved and to represent the information users on the relevant standards committees etc which are drawing up functional requirements. In this regard the initiative taken by Learned Information on behalf of the information providers, with their Optical Disk Forum is to be commended and could, perhaps, be emulated by a similar organisation representing the library and end user community.

Suiting the Medium to the Message

With all due respect to Marshall Mcluhan, we feel that with optical discs it is very important

not to let the medium dictate the message. CD ROMs, videodiscs etc are now commercially available and are being actively promoted by suppliers and industry pundits. There is a great danger that, in order to be seen to be at the forefront of technology, publishers will scan their inventory for suitable products and then simply issue them on CD ROM. This is surely the wrong approach and one that will lead to significant amounts of money being invested with very little return. What publishers should be doing, in consultation with librarians and other end user groups, is looking for areas where needs have not been met in the past by online or microfilm or paper publications and then seeing which, if any, of the optical disc systems could meet those needs.

Such work is already being done by large publishers, from their own resources but for smaller publishers and end user groups the most helpful approach will be for the societies and associations which serve the publishing and library world to monitor the usage being made of the optical disc systems currently and to show what products are successful and what are not and why, to investigate the true costs of producing different discs and supplying users with hardware and report back these findings and to question initial users of optical disc systems and report back their experiences.

In the videodisc area with job is done extremely efficiently in the UK by the National Interactive Videodisc Centre (NIVC). In the publishing area, the International Electronic Publishing Research Centre (IEPRC) are monitoring developments and Learned Information are well positioned to cover the impact of optical publishing on the online database industry. When it comes to the impact of optical publishing on libraries then the professional library associations in individual countries and the National Libraries, through their research programmes, have a major role to play. In the UK the British Library Research & Development Department have supported and are supporting a number of specific projects relating to the use of optical discs in the information field and a number of the centres which they support such as Cimtech (the Centre for Information Media & Technology) and the Library Technology Centre in the UK have carried out research in this area and will be well equipped to advise libraries on the best use of this technology.

Similar work is being done in Europe, the USA and Japan and organisations such as IFLA and FID could play a significant role in helping to coordinate research in the library world and disseminating the findings of relevant research programmes throughout the world via conferences and publication programmes.

Technical and Logistical Considerations

Assuming that standardisation issues are dealt with and valuable products are distributed on optical media, the next pressing set of questions that need to be investigated by the library world relate to how optical disk workstations would be configured and implemented and how easily they could be used by either academic staff or library staff or end users in public and industrial libraries. In addition, there are practical administrative problems such as how discs would be acquired, stored, handled and made available to the public for reference or loan.

As described in chapters two and three a wide range of computer companies, intermediaries and publishers are beginning to distribute material on hybrid videodiscs and CD ROMs and over the next two years CDI's will begin to become available. If libraries are not careful they will find themselves purchasing equipment that is of limited value because only a few specialised titles can be played on it or which provide them with very disappointing response

times, searching facilities etc simply because they did not have the time or expertise to examine in detail the implications of purchasing one system rather than another.

Clearly, again, organisations in both the public and private sector such as Learned Information, Cimtech, Elsevier, Aslib, the Library Association, IEPRC and the general computer press, who publish news of new equipment and evaluations of hardware and software products will begin to cover optical workstations etc when they come onto the market in volume and valuable guidance will be found from these sources on how to evaluate such equipment, parameters to apply etc but there will also be a need for specific practical research programmes to consider a range of factors relating to the design of such optical workstations.

One project of relevance here is Project Quartet - a £ 794,000 research project funded by the British Library's Research & Development Department (BLR&DD) to develop an advanced electronic information system for researchers. The research for the project will be carried out over 3 years by the University of Birmingham, Hatfield Polytechnic, Loughborough University of Technology and University College London in cooperation. Project Quartet will make possible the development of single integrated information storage and communication systems by bringing together research into computer networking, optical mass data storage and retrieval and visual display techniques.

One of the aims of the project will be the development of electronic workstations from which users will be able to access large stores of information and communicate with other research workers. The optical storage element will take the form of CD ROM systems for local delivery of multimedia information as well as other forms for mass storage on remote or distributed databases. Hatfield Polytechnic has made a particular study of this area over the past few years and will be responsible for the optical storage research. One particular problem that will be investigated is how to structure the large data files involved in order to optimise retrieval.

Part of Project Quartet will involve setting up user groups to evaluate alternative workstation configurations, data formatting on the screen, application software etc and there is clearly a need for further research in this area. When Computer Output Microfiche and viewdata dissemination systems were first introduced, the BLR&DD sponsored research by Linda Reynolds of the Royal College of Art on how screens of data could best be formatted for display and there will be a need for considerable research in this area to see the most effective way of presenting information stored on CD ROM.

Other areas where research is needed in the library world, as elsewhere, will now be in comparing the capabilities offered by CDI and CD ROM systems and making recommendations as to which system is more effective for different categories of material; looking at the whole question of user interfaces to determine the ideal amount of help facilities and the usual trade offs between making a system easy to use and offering fast, direct retrieval of information for experienced users and, finally, looking at the question of image storage on optical discs and what resolution will be required, what the implications are in terms of hardware requirements and workstation costs and what technologies are likely to offer cost effective solutions?

Paper, microfilm and online distribution systems have progressively offered librarians more and more potential benefits but the cost has been that librarians have found themselves involved in making decisions about the purchase of more and more sophisticated equipment and systems and hence the need for guidance has become greater. The advent of optical disc

systems will accelerate that trend, increasing the potential benefits but at the same time increasing the pitfalls. Above we have shown some areas where the library profession and the organisations which serve it can ease the move into optical storage but in the final section of this chapter we will face one of the most fundamental issues which optical systems and incresing automation poses and that is - what does the future hold for libraries.

The Impact of Optical Disc Systems on Existing Library Services and Pratices

In this final section we try and give a realistic assessment of the impact that some of the optical disc systems described above, and some of the trends which they encourage, could have on traditional library activities and services and the way in which libraries are organised in the future.

It can be stated with a fair degree of confidence that no matter how successful CDI and CD ROM based optical publishing systems are they will have very little impact on the loan services offered by public and academic libraries for at least the next five years and we would expect for the next ten years. People will continue to want to read novels and textbooks on the train, at home and at educational establishments, workbreaks etc and no optical publishing medium will significantly impact that market.

However, when it comes to reference services in public, academic and special libraries then we consider that optical disc systems will have a significant impact in the medium to long term and we will begin to see a significant decline in the number of directories and other hardcopy publications held by reference libraries from the end of the decade onwards. Some of the directories will be replaced by CD ROMs and CDI's held in the libraries themselves and accessed by library staff and end users but, particularly in special libraries, many will just disappear to be replaced by CD ROM databases distributed to end users who will use them themselves at their own PC workstation.

The availability of specialised databases aimed at particular categories of professional workers on CD ROM with user friendly search software and the ability to transfer data from the CD ROM to local files on the PC for processing will mean that gradually, individual knowledge workers' dependency on external library services could decline significantly. Examples of this could include financial, legal, medical and engineering databases.

In addition to reducing the stock of hardcopy directories that needed to be held by the library, the widespread availability of specialised optical databases could also reduce significantly the number of online searches the library was asked to make and the number of journal article requests that the libraries would be asked to action. However, we feel that this trend can be overemphasised as most knowledge workers do not consider it part of their job to conduct complex database searches and will still prefer to request information rather than search for it themselves and hence user take up of such services could be fairly slow until the use of artificial intelligence allows users to interrogate databases verbally and set up sophisticated SDI (Selective Dissemination of Information) profiles themselves and that scenario is still a long way off.

A second area where optical disc systems will impact on the role of academic and special libraries as repositories of published information will be when the electronic document delivery services currently under development and described in chapter three, become technically and economically feasible and libraries/end users can literally request the full text

of documents as easily as bibliographic references. Such systems are still, in our view, three to four years away and even then they will tend to be limited in scope but as soon as they become available, libraries would be able to cut back significantly on local holdings.

If these two trends - towards personal databases and centralised document delivery services - seem to threaten the status of librarians, one other trend offers scope for a significant enhancement of their status in commercial and public sector organisations. This is the growing move towards the use of sophisticated optical disk based document and data filing systems in organisations to control their inhouse databases. If, as seems likely, the same, or similar database management systems are employed to index and retrieve documents captured inhouse and stored locally on recordable digital optical disks as are used today to build up and search commercial bibliographic and full text databases online then the librarians and information scientists who have controlled that organisation's use of online databases in the past will be well equipped to supervise the creation of such inhouse databases and librarians could find themselves being recruited to attend records management committees and being asked for advice on how to create databases, thesauruses etc. This, we feel, represents a significant opportunity for librarians and information scientists in future provided they are prepared to take it and promote their expertise in this area.

Hence, for special libraries in particular, we see three main trends, a move away from published works of reference to specialised information provision services based around the use of CD ROM and other optical media and geared to specific knowledge workers; the gradual move away from locally held reference works and periodical collections to sophisticated centralised document delivery services and thirdly, growing links between library services and inhouse records management and data archiving functions as all three tend to use the same hardware and software elements.

Only time will tell exactly what impact optical media will have on libraries - much of it will depend on the ingenuity and resources of publishers and libraries and the demands made by end users once they become aware of the potential - but one thing is sure now - optical disc systems will not go away and over the next ten years they are set to have as big an impact on the publishing, library and records filing world as paper did when it was first invented. The title of an excellent book on CD ROM which has recently published by Microsoft Press is equally applicable to all the optical disc systems we have been describing - "CD ROM - The New Papyrus" (6).

Appendix 1

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Appendix 2

Journals and newsletter and sources of further information

UK Newsletters and Journals

The Electronic Library. - Abingdon (Oxford, OX13 6 LG) : Learned Information Besselsleigh Road

Electronic Publishing Review. - Abingdon (Oxford, OX13 6 LG) : Learned Information, Besselsleigh Road

Information Media & Technology : The Journal of Cimtech. - Hatfield (Hertfordshire, AL10 9 AB) : The Hatfield Polytechnic, P O Box 109, College Lane.

Optical Data Systems. - Alton (Hampshire, GU34 2PG) : Microinfo Ltd., P O Box 3, Newman Lane.

US Newsletters and Journals

CD DATA Report. - Mclean, VA 22101, USA : Langley Publications, Suite 115 324, 1350 Beverly Road

Optical Information Systems. - Westport, CT 06880, USA : Meckler Publishing, 11 Ferry Lane West

Optical Information Systems Update. - Westport, CT 06880, USA : Meckler Publishing, 11 Ferry Lane West

Optical Information Systems Update / Library & Information Centre Applications. - Westport, CT 06880, USA : Meckler Publishing, 11 Ferry Lane West

Optical Memory News. - San Francisco, CA 94114-0817, USA : Rothschild Consultants, P O Box 14817

The Videodisc Monitor. - Falls Church, VA 22046, USA, P O Box 26

Sources of Further Information

Cimtech, the Centre for Information Media & Technology, Hatfield Polytechnic, P O Box 109, College Lane, Hatfield, Hertfordshire, AL10 9 AB

The International Electronic Publishing Research Centre, c/o PIRA, Randalls Road, Leatherhead, Surrey, KT22 7RU

The National Interactive Video Centre, 27 Marylebone Road, London, NW1 5 JS

The Optical Disk Forum, Secretariat, Learned Information Ltd., Abingdon, Oxford, OX13 6LG

The series, IFLA Professional Reports, is published under the auspices of the Professional Board by the IFLA Secretariat. The publications in the series are available from IFLA Headquarters, POB 95312, 2509 CH The Hague, Netherlands for Dfl 22.00 or US$ 10.00 or their equivalent in other currency, including airmail postage. Please enclose a check or money order when placing your order. Unesco coupons are also accepted.

1. Books for the mentally handicapped. A guide to selection. Compiled by Margaret R. Marshall, Sancia Simonis-Rupert and Susanne Holst under the auspices of the Section of Children's Libraries and the Section of Library Services to Hospital Patients and Handicapped Readers.

2. Guidelines for libraries serving hospital patients and disabled people in the community. Compiled by a working group chaired by Jean M. Clarke under the auspices of the Section of Library Services to Hospital Patients and Handicapped Readers.

3. Poster sessions in library science: guidelines. By Dieter Schmidmaier under the auspices of the Section of Science and Technology Libraries.

4. The international guide to publishers and distributors of large print. By Bruce E. Massis under the auspices of the Section of Libraries for the Blind.

5. The impact of information technology upon public libraries. Compiled by a working group under the auspices of the Section of Public Libraries.

6. Recommendations for a retrospective bibliographic control. Compiled by Marcelle Beaudiquez under the auspices of the Section on Bibliography.

7. Transborder flow of bibliographic data. By Lenore S. Maruyama under the auspices of the Section on Information Technology.

8. Principles for the preservation and conservation of library materials. By J.M. Dureau and D.W.G. Clements under the auspices of the Section on Conservation.

9. Guidelines for the education and training of school librarians. Compiled and edited by Sigrún Klara Hannesdóttir under the auspices of the Section of School Libraries.

10. Standards for university libraries. Edited by Beverly P. Lynch under the auspices of the Section of University Libraries and other General Research Libraries.

11. International directory of libraries for the blind. Compiled by Clifford Law and Kathy Moignard under the auspices of the Section of Libraries for the Blind.

12. Optical disk systems: a guide to the technology and the applications in the fields of publishing and library and information work. By A. M. Hendley under the auspices of the Section on Information Technology.